

**ENCYCLOPÆDIA BRITANNICA.**

**VOLUME the FIRST.**



*Josh. Baskin.*

ENCYCLOPÆDIA Britannica:

*Altho* OR, A *1774.*

D I C T I O N A R Y

O F

A R T S and S C I E N C E S,

COMPILED UPON A NEW PLAN.

I N W H I C H

The different SCIENCES and ARTS are digested  
into distinct Treatises or Systems;

A N D

The various TECHNICAL TERMS, &c. are explained as they  
occur in the order of the Alphabet.

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ILLUSTRATED WITH ONE HUNDRED AND SIXTY COPPERPLATES.

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*By a SOCIETY of GENTLEMEN in SCOTLAND.*

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I N T H R E E V O L U M E S.

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V O L. I.

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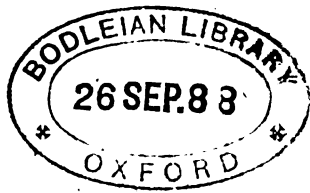
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P R E F A C E.

**T**HE method of conveying knowledge by alphabetical arrangement, has of late years become so universal, that Dictionaries of almost every branch of literature have been published, and their number still continues to increase. The utility of this method is indeed obvious; and experience has given it the stamp of approbation.

AMONG the various publications of this class, those of the greatest importance are General Dictionaries of Arts and Sciences: But it is to be regretted, that these, of all other kinds of Dictionaries, have hitherto fallen shortest of their purpose, and yielded the least satisfaction. This is not owing, as some have imagined, to the nature of the alphabetical plan, as being incompatible with an object so complex and extensive as a digest of the whole body of Arts and Sciences; but to an unaccountable inattention to the proper method of making that digest, and to the no less unaccountable attachment which Compilers seem to have to the preposterous method of dealing out the Sciences in fragments, according to the various technical terms belonging to each: A method repugnant to the very idea of science, which is a connected series of conclusions deduced from self-evident or previously discovered principles; which principles, with the relations of the different parts of science, cannot be comprehended by the learner, unless they are laid before him in one uninterrupted chain. Dictionaries of Language, of Trade, of Political Geography, Biographical Dictionaries, Classical Dictionaries, and others of the like nature, whose subjects comprise a multitude of particulars unconnected with each other, among which there is no reason for precedence in order, better than what each derives from the letters by which it is expressed, can scarce be improperly executed as to the general arrangement; and therefore, if each article be accurate in itself, the whole will generally give all the satisfaction expected from such books. But the systematic nature of the Sciences will not admit of their being dismembered, and having their parts subjected to such fortuitous distributions: Yet they have suffered this violence in all the Dictionaries hitherto published; and hence the dissatisfaction and complaints of all those who have had occasion to consult them.

IN a Work of this kind, the Sciences ought to be exhibited entire, or they are exhibited to little purpose. The absurdity and inefficacy of the contrary method, which has hitherto obtained, will be evident from an example or two. Suppose, then, you want to obtain some knowledge of AGRICULTURE: You reasonably expect to be gratified by consulting one or other of these Dictionaries; as in all their Prefaces or Introductions the reader is taught to believe, that they contain the whole circle of Science and Literature, laid down in the most distinct, and explained in the most familiar, manner. Well, how are you

you to proceed? The science is scattered through the alphabet under a multitude of words, as Vegetation, Soil, Manure, Tillage, Fallowing, Plough, Drain, Sowing, Marle, Chalk, Clay, Loam, Sand, Inclosure, Hedge, Ditch, Wheat, Barley, Harrow, Seed, Root, &c. &c. After consulting a few of these articles, ignorant at the same time in what order you should have taken them, new references unexpectedly spring up, and multiply so thick, that you suddenly find yourself bewildered as in a labyrinth, without a clue to direct your course; and if haply you get through all the windings, you are still as far from the end of your inquiry as ever. To think of collecting a distinct or connected Whole from such a farrago, is vain: As well might you hope to acquire the idea of an edifice, the form of which is entirely demolished, from being shewn the scattered stones which once composed it.—But is there nothing to the purpose under the leading word, AGRICULTURE, itself? No. After a definition of the word, the signification of which nobody is supposed to be ignorant of, you have a descant upon the uses of the science, which every person must be sensible of, and then a few words upon its origin, which scarce any body can be at a loss to trace, without the help of a Dictionary. But nothing to the main point; no elements of the science, no particulars relating to the practice: But to complete the mortification of the wearied inquirer, he is at last given to understand, that he must for satisfaction have recourse to such and such authors who have written upon the subject; and these he must be at the expence of purchasing, or find other means than what his Dictionary affords of attaining the desired information.

SUCH are the defects of the old plan with regard to the Sciences: And so fond do the Compilers seem of derangement and demolition wherever it can be effected, that instead of giving a connected detail even of such subjects as according to their own plan naturally admit of being treated fully under one word, they industriously split them into many. For example, you want to know the history of BEES, their œconomy and various operations. You therefore look out the word BEE, and are told it is “An insect of which there are a great many species, &c. See APIS.” Upon turning to APIS, “APIS, in zoology, a genus of four-winged insects, having their tails furnished with a sting, &c. See BEE, SWARM, HIVE, HONEY, WAX, &c.” Well, you turn to the next word referred to, “SWARM of Bees. See HIVE.” Upon consulting HIVE, you are told it is “A convenient receptacle for bees. See BEE.” Then mention is made of two or three sorts of them, of which no other account is given, but that some are made with willow, others with straw; some of wood, others of glass; and that their usual form is conical. And so, with much the same satisfaction, you are carried through *Hiving, Honey, Honey-comb, Wax, &c.*; and after being referred back from the last article to *Honey-comb, Honey, Hive, Bee, Apis*, you perhaps throw down the book in the heat of disappointment.—It is difficult to assign a reason for this conduct. Perhaps this way of splitting one article into several, and  
saying

saying something upon each, may be intended to give the book an appearance of greater copiousness: But the discerning reader will see through the device, and condemn a Work that would subject him to the labour of consulting twenty words in place of one, and where disappointment would most frequently be the result of his labour.

HERE the Editors think it necessary to declare, That while their subject leads them to the consideration of the defects of the common plan of Dictionaries of Arts and Sciences in general, they are very far from meaning to point their reflections against any of these works in particular. Neither do they pretend to controvert the real utility of such performances, when accurately executed. On the contrary, notwithstanding the reigning defect above animadverted on, their uses must be acknowledged to be neither few nor unimportant. Besides teaching the language, and explaining the terms, of Science, they exhibit a multitude of useful and interesting Articles, which are not properly comprehensible under any system, or are of such a nature as not to suffer prejudice by being detached. But still these uses are infinitely inferior to what ought to be made the chief object of such an undertaking, namely, not merely to explain the Language or the Terms of Science, &c. but to communicate in a connected and intelligible manner the Sciences themselves. The Editors, therefore, while they do not mean to detract from the utility of these performances, cannot help taking notice of defects which prevent that utility from having a wider range.

WITH a view to remedy these defects, and render a distinct knowledge of the Sciences attainable, the following Work has been planned. Being the first attempt of the kind, extensive in its nature, and difficult in the execution, it is offered to the Public with the utmost diffidence, and under a full sense of its requiring their utmost candour and indulgence.

IN composing it, the defects of the old plan have not been supplied at the expence of any of its advantages. The plan here adopted is twofold: *Systematical*, and *Detached*. To have made it a work consisting entirely of systems, would, in order to avoid one extreme, have been running into another: And though, by constituting a Body of Arts and Sciences, it would have been in itself a work of more value and importance, it would perhaps have been less generally acceptable, than a simple Dictionary; as the studious and the laborious reader belongs to a class far less numerous than that of the superficial and the indolent. It is to readers of the former cast that the old plan is obnoxious, as being too flimsy and unsatisfying. Readers of the latter sort, again, would naturally object to the systematic plan, and be apt to exclaim, "We do not want to doze over treatises, or to rake through systems; we want an explanation of words or terms which we can readily turn to for occasional consultation." A work of this nature, therefore, in order to be of general utility, ought to be  
upon

upon a plan calculated to satisfy every reader, whether he may want the ready explanation of a particular Term, &c. or the entire view of a whole Science: And such is the scheme of the present undertaking.

1. IN the *systematic* part,---Agriculture, Algebra, Anatomy, Architecture, Arithmetic, Astronomy; Botany, Book-keeping; Chemistry, Commerce, Conic Sections; Dialling; Electricity; Farriery; Fluxions, Fortification; Gardening, Geography, Geometry, Grammar, Gunnery; Horsemanship, Hydrostatics; Law, Logic; Mechanics, Medicine, Metaphysics, Midwifery, Moral Philosophy, Music; Natural History, Navigation; Optics; Perspective, Pneumatics; Religion or Theology; Short-hand Writing, Surgery; Trigonometry; with all the other and lesser Arts and Sciences; are composed in the form of distinct Treatises or Systems, and illustrated with a great number of elegant Copperplates. In these, the reader has the different subjects discussed in a complete and methodical manner, without being distracted with references: And instead of being amused with a list of books to be consulted, he is here presented with the very books themselves,---either at large, when a compendium would be insufficient,---or abridged, when (as is frequently the case) to abridge is to improve. It is, however, to be observed, that there are several Sciences, of which there are no good treatises to be had, or which have not been treated in all their parts by any author. In these instances, the Treatises presented are either original; or partly original, partly compiled; or compiled from various authors, who have each written upon particular parts, but not upon the whole in the form of a system.

2. IN the *detached* part,---the subjects of Natural History, as Quadrupeds, Birds, Fishes, Amphibious Animals, Insects, and Plants, are all reduced to their several classes, orders, genera, and species, according to the system of the celebrated Linnæus; and an account given of their nature, food, instincts, manner of living, and other curious and entertaining parts of their history.---Such articles as could not with propriety be comprehended under any particular system, of which there is a very large number, many of them original, are fully treated under their proper names.

IT is a disagreeable office for writers to enlarge on the nature of their own performances. Facts, however, may be told, without any offence to modesty. Whoever peruses this Work, will find, that besides a vast number of curious and instructive articles, it contains the substance of as many valuable books of science as would make no inconsiderable library; such a library, indeed, as could not be purchased for twenty times the price of the Work itself. In every book there are excrescences; in preparing the Systems which appear in this Publication, the Compilers lopt off these excrescences, retrenched superfluities, and in short rejected every thing that was not strictly connected with the subject. By these means they have been enabled (they flatter themselves) to comprise a great deal of substantial knowledge in a short compass, and at the same time to preserve the spirit and manner of the different authors.



# Encyclopædia Britannica;

OR, A NEW AND COMPLETE

## D I C T I O N A R Y

O F

### A R T S and S C I E N C E S.

#### A B

**A**, the name of several rivers in different parts of the world, viz. 1. of one in Solagne, in France; 2. of one in French Flanders; 3. of three in Switzerland; 4. of five in the Low Countries; 5. of five in Westphalia; 6. of one in Livonia.

**AABAM**, a term, among alchemists, for lead.

**AACH**, the name of a town and river in Swabia. It is also a name sometimes given to Aix-la-chapelle.

**AADE**, the name of two rivers, one in the country of the Grisons in Switzerland, and the other in Dutch Brabant.

**AAHUS**, a small town and district in Westphalia.

**AAM**, a Dutch measure for liquids, containing about 63 lb. avoirdupoise.

**AAMA**, a province in Barbary, very little known.

**AAR**, the name of two rivers, one in Westphalia, and one in Switzerland. It is likewise the name of a small island in the Baltic sea.

**AARSEO**, a town in Africa, situated near the mouth of the river Mina.

**AATTER**, or **ATTEA**, a province of Arabia Felix, situated on the Red-sea.---N. B. All other places which begin with a double A, but more generally with a single one, will be inserted according to the last orthography.

**AB**, the eleventh month of the civil year of the Hebrews. It corresponds to part of our June and July, and consists of 30 days. On the first of this month the Jews commemorate the death of Aaron by a fast: they fast also on the ninth, because on that day both the temple of Solomon and that erected after the captivity were burnt. The same day is also remarkable for the publication of Adrian's edict, prohibiting the Jews to look back, even when at a distance, upon Jerusalem, or to

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#### A B A

lament its desolation. The lamp of the sanctuary, in the time of Ahaz, was extinguished on the night of the 18th, for which reason the Jews fast that day. See *ASTRONOMY, Of the division of time.*

**AB**, in the Syriac calendar, is the name of the last summer-month.

**ABACATUAIA**, in ichthyology, a barbarous name of the zeus vomer, a fish belonging to the thoracic order of Linnaeus. See *ZEUS.*

**ABACAY**, a barbarous name of a species of the psittacus, or parrot. See *PSITTACUS.*

**ABACH**, a town in Bavaria, situated on the Danube, a little above Ratibon.

**ABACISCUS**. See *ABACUS.*

**ABACO**, a term, among ancient writers, for arithmetic.

**ABACOA**, the name of one of the Bahama islands. See *BAHAMA.*

**ABACOT**, the name of an ancient cap of state worn by the kings of England, the upper part whereof was in the form of a double crown.

**ABACTORES**, or **ABACTORS**, a term for such as carry off or drive away a whole herd of cattle by stealth.

**ABACTUS**, an obsolete term, among physicians, for a miscarriage procured by art.

**ABACUS**, a table strewed over with dust or sand, upon which the ancient mathematicians drew their figures. It also signified a cupboard, or buffet.

**ABACUS**, in architecture, signifies the superior part or member of the capital of a column, and serves as a kind of crowning to both. It was originally intended to represent a square tile covering a basket. The form of the abacus is not the same in all orders: in the Tuscan, Doric, and Ionic, it is generally square; but in the Corinthian and Composite, its four sides are arched inwards, and embellished in the middle with some

† A

some

some ornament, as a rose or other flower. Scamozzi uses *abacus* for a concave moulding on the capital of the Tuscan pedestal; and Palladio calls the finch above the echinus, or *bouche*, in the Tuscan and Doric orders, by the same name. See plate I. fig. 1. and ARCHITECTURE.

**ABACUS** is also the name of an ancient instrument for facilitating operations in arithmetic. It is variously contrived. That chiefly used in Europe is made by drawing any number of parallel lines at the distance of two diameters of one of the counters used in the calculation. A counter placed on the lowest line, signifies 1; on the 2d, 10; on the 3d, 100; on the 4th, 1000, &c. In the intermediate spaces, the same counters are estimated at one half of the value of the line immediately superior, viz. between the 1st and 2d, 5; between the 2d and 3d, 50, &c. See plate I. fig. 2. A B, where the same number, 1768 for example, is represented under both by different dispositions of the counters.

**ABACUS harmonicus**, among musicians, the arrangement of the keys of a musical instrument.

**ABACUS logisticus**, a right-angled triangle, whose sides forming the right angle contain the numbers from 1 to 60, and its area the facta of every two of the numbers perpendicularly opposite. This is also called a canon of sexagesimals.

**ABACUS Pythagoricus**, the multiplication-table, or any table of numbers that facilitates operations in arithmetic.

**ABADAN**, a town of Persia, situated near the mouth of the Tygris.

**ABADDON**, from *abad*, to destroy; a name given by St John, in the Revelations, to the king of the locusts.

**ABADIR**, a title which the Carthaginians gave to gods of the first order. In the Roman mythology, it is the name of a stone which Saturn swallowed, believing it to be his new-born son Jupiter: hence it became the object of religious worship.

**ABÆRE**, a town in the deserts of Arabia.

**ABAFT**, a sea-term, signifying *towards the stern*: for instance, *abaft the mizzen-mast*, implies, that the object is between the mizzen-mast and the stern.

**ABAI**, in botany, a synonyme of the *calycanthus præcox*, a genus of plants belonging to the icofandria polygynia class of Linnæus. See CALYCANTHUS.

**ABAISSE**. See ABASED.

**ABALIENATION**. See ALIENATION.

**ABANBO**, a river of Ethiopia which falls into the Nile.

**ABANCAI**, or **ABANCAYS**, a town and river of Peru, in the district of Lima.

**ABANO**, a small town in Italy, subject to Venice, and situated five miles south-west of Padua.

**ABAPTISTON**, or **ANABAPTISTON**, an obsolete term for the surgical instrument called a *trepan*. See SURGERY, and *Trepan*.

**ABARCA**, a shoe made of raw hides, formerly worn by the peasants in Spain.

**ABARTICULATION**, in anatomy, a species of articulation which is now termed *diarthrosis*. See ANATOMY, Part I. and *Diarthrosis*.

**ABAS**, a weight used in Persia for weighing pearls. It is 1-8th less than the European carat.

**ABASCIA**, the country of the Alcas. See ALCAS.

**ABAISED**, *Abaisse*, in heraldry, an epithet applied to the wings of eagles, &c. when the tip looks downwards to the point of the shield, or when the wings are shut; the natural way of bearing them being extended.

**ABASING**, in the sea-language, signifies the same as striking.

**ABASSI**, or **ABASSIS**, a silver coin current in Persia, equivalent in value to a French livre, or tenpence half-penny Sterling. It took its name from Schaw Abas II. king of Persia, under whom it was struck.

**ABATAMENTUM**, in law, is an entry to lands by interposition, i. e. when a person dies seized, and another who has no right enters before the heir.

**ABATE**, from *abatere*, to destroy; a term used by the writers of the common law, both in an active and neutral sense; as, to *abate* a castle, is to destroy or beat it down; to *abate* a writ, is, by some exception to render it null and void.

**ABATE**, in the manage, implies the performance of any downward motion properly. Hence a horse is said to *abate*, or take down his curvets, when he puts both his hind-legs to the ground at once, and observes the same exactness in all the times.

**ABATEMENT**, in heraldry, implies something added to a coat of arms in order to lessen its dignity, and point out some imperfection or stain in the character of the wearer.

**ABATEMENT**, in law. See ABATE.

**ABATEMENT**, in commerce, signifies an allowance or discount in the price of certain commodities, in consideration of prompt payment, a diminution in the stipulated quantity or quality of goods, or some such circumstance.

**ABATEMENT**, in the customs, an allowance made upon the duty of goods, when the quantum damaged is determined by the judgment of two merchants upon oath, and ascertained by a certificate from the surveyor and land-waiter.

**ABATIS**, an ancient term for an officer of the stables.

**ABATOR**, in law, a term applied to a person who enters to a house or lands, void by the death of the last possessor, before the true heir.

**ABAVO**, in botany, a synonyme of the *adanfonia*, a shrub belonging to the monadelphia polyandria of Linnæus. See ADANSONIA.

**ABAYANCE**. See ABEYANCE.

**ABB**, a term, among clothiers, applied to the yarn of a weaver's warp. They also say *Abb-wool* in the same sense.

**ABBA**, in the Syriac and Chaldee languages, literally signifies a *father*; and figuratively, a superior, reputed as a father in respect of age, dignity, or affection. It is also a Jewish title of honour given to some of the class called Tanaites.

**ABBAT**. See ABBOT.

**ABBATIS**. See ABATIS.

**ABBEFORD**, a sea-port town in Norway, in 58. 44. N. lat.

**ABBESS**, the superior of an abbey or convent of nuns, over whom she has the same authority as the abbots over the monks. Their sex indeed hinders them from performing

forming the spiritual functions; but in the 12th century there were abesses in Spain who gave benedictions, and confessed people of both sexes.

**ABBEVILLE**, a large city of Piccardy in France, lying 90 miles north of Paris, in 50. 7. N. lat. and 2. 0. E. long.

**ABBEY**, a religious house, governed by an abbot, where persons retire from the world, to spend their time in solitude and devotion. By the invention of masses for the living and the dead, dispensations, jubilees, indulgences, &c. the abbeyes procured such large privileges, exemptions, and donations, that, when these houses were totally abolished in England by Henry VIII. to the number of 190, an yearly revenue of L. 2,853,000 reverted to the crown.

**ABBEY-BOYLE**, a town in the county of Roscommon in Ireland.

**ABBOT**, the superior of an abbey or convent of monks. In the first ages of Christianity, the abbots were plain disinterested men, and lived contented with the government of their monasteries, which were generally erected in the most solitary parts: but being called from their deserts to oppose the heresies in the church, they soon began to entertain sentiments of ambition, and endeavoured to shake off their dependency on the bishops. Hence arose the distinctions of *mitred abbots*, *croziered abbots*, *ecumenical abbots*, *cardinal abbots*, &c. The principal distinction which subsists at present among abbots, is that of *regular* and *commendatory*; the former of which take the vow, and wear the habit of the order; the latter are seculars, though they are obliged to take orders at the proper age. Before the Reformation in England, there were abbots elective and representative; some mitred, and others not. The mitred abbots were invested with episcopal authority within their own limits, independent of the bishop; but the others were subject to the diocesan in all spiritual government. The mitred abbots were Lords of parliament, of which number Sir Edward Coke reckons 27, who sat in parliament, besides two Lords Priors.

**ABBREVIATE** of *adjudications*, in Scots law, an abstract or abridgment of a decret of adjudication, which is recorded in a register kept for that purpose. See *Scots Law*, title, *Adjudications*.

**ABBREVIATION**, or **ABBREVIATURE**, implies the substitution of a syllable, letter, or character, for a whole word.

**ABBREVIATOR**, a person who abridges any large book into a narrower compass.

**ABBREVIATORS**, a college of 72 persons in the chancery of Rome, who draw up the pope's briefs, and reduce petitions into proper form.

**ABBREVOIR**, a term in masonry, expressive of certain indentures made in the joints or beds of stones, which being filled with the cement or mortar, bind them firmer together.

**ABROCHMENT**. See **ABROCHMENT**.

**ABBUTTALS**, signify the buttings or boundings of land towards any point. Limits were anciently distinguished by artificial hillocks, which were called *battens*,

*tines*, and hence *butting*. In a description of the site of land, the sides on the breadth are more properly *adjacentes*, and those terminating the length are *abbutantes*; which, in old surveys, were sometimes expressed by *capitare*, to head; whence abbuttals are now called *head lands*.

**ABCASSES**, a people or country in Asia, situate between Circassia, the Black-sea, and Mingrelia.

**ABCDARIA**, in botany, a synonyme of the *verbescina acmella*. See **VERBESINA**.

**ABCDARY**, or **ABCDARIAN**, an epithet applied to compositions, whose parts are disposed in an alphabetical order.

**ABDALS**, or *servants of God*, in the Eastern countries; furious enthusiasts, who frequently run about the streets, destroying all who differ from them in religious opinions.

**ABDELAVI**, in botany, a name used by Arabian writers for a species of *cucumis*. See **CUCUMIS**.

**ABDEST**, a term used for the legal purifications by water, practised among the Mahometans and Persians before they begin their religious ceremonies.

**ABDICARIAN proposition**, in logic, the same with a negative one. See **LOGIC**, and *Proposition*.

**ABDICATION**, the action of renouncing or giving up an office.

**ABDOMEN**, in anatomy, is that part of the trunk of the body which lies between the thorax and the bottom of the pelvis. See **ANATOMY**, part VI.

**ABDUCTION**, a form of reasoning among logicians, which consists in drawing conclusions from certain and undeniable propositions. See **LOGIC**.

**ABDUCTION**, in surgery, a species of fracture wherein the broken parts of the bone recede from each other. See **SURGERY**, *Of fractures*.

**ABDUCTOR**, in anatomy, the name of several muscles which serve to open or draw back the parts to which they are fixed. See **ANATOMY**, Part VI.

**ABEL-TREE**, or **ABELE-TREE**, an obsolete name for a species of the poplar. See **POPULUS**.

**ABELIANS**, **ABELOITES**, or **ABELONIANS**, a sect of heretics that sprung up near Hippo in Africa during the reign of Arcadius. They had one distinguishing and extraordinary tenet, which was to marry, but never to consummate.

**ABELMOSCH**, or **ABELMUSCH**, in botany, the trivial name of a species of the hibiscus. See **HIBISCUS**.

**ABENSBURG**, or **ABENSPERG**, a small town in Bavaria, on the river Abenz, near the Danube.

**ABERBROTHOCK**, one of the royal boroughs of Scotland, situated in the county of Angus, about 40 miles north of Edinburgh. Its west long. is 2. 20. and N. lat. 56. 30. There was formerly one of the richest monasteries in Scotland in this town. It was founded by King William of Scotland about the year 1170, in honour of Thomas Becket Archbishop of Canterbury, with whom he is said to have been intimately acquainted. This monastery received considerable donations from Gilchrist Earl of Angus, and Gilbred his son. It was possessed by the monks of St Bennet. The inhabitants of Aberbrothock, for the sake

fake of their monastery, were made demerons of all England (London excepted) by King John.

**ABERDEEN**, the name of two cities in Scotland, called the *Old and New Towns*, situated on the German Ocean, in 1. 45. W. lon. and 57. 11. N. lat.

The old town lies about a mile to the north of the new, at the mouth of the river Don, over which is a fine bridge, of a single arch, which rests at both sides on two rocks. The old town was formerly the seat of the bishop, and had a large cathedral church, commonly called *St Machar's*. This cathedral had anciently two rows of stone pillars across the church, and three turrets; the steeple, which was the largest of these turrets, rested upon an arch, supported by four pillars. In this cathedral there was a fine library; but about the year 1560 it was almost totally destroyed.

But the capital building is the King's-college, on the south side of the town, which is a large and stately fabric. The steeple is vaulted with a double cross arch, above which is an imperial crown, supported by eight stone pillars, and closed with a globe and two gilded crosses. In the year 1631 this steeple was thrown down by a storm, but was soon after rebuilt in a more stately form. This college was founded by Bishop Elphinston in the year 1500; but James IV. claimed the patronage of it, and it has since been called the *King's College*. This college, and the Marishall-college in the new town, form one university, called the *University of King Charles*.

The new town is the capital of the shire of Aberdeen. For largeness, trade, and beauty, it greatly exceeds any town in the North. It stands upon a hill or rising ground. The buildings are generally four stories high, and have, for the most part, gardens behind them, which gives it a beautiful appearance. On the high street is a large church, which formerly belonged to the Franciscans. This church was begun by Bp William Elphinston, and finished by Gavinus Dunbar, Bishop of Aberdeen, about the 1500. Bp Dunbar is said likewise to have built the bridge over the Dee, which consists of seven arches. The chief public building in the new town is the Marishall-college, founded by George Keith Earl of Marhall, in the year 1593; but has since been greatly augmented with additional buildings. In both the Marishall and King's-college the languages, mathematics, natural philosophy, divinity, &c. are taught by very able professors.

**ABERDOUR**, a small town in Fifeshire, Scotland, on the frith of Forth, about ten miles N. W. of Edinburgh.

**ABERGAVERY**, in Monmouthshire, England, a well-built town, lying 142 miles W. by N. of London, in 51. 50. N. lat. and 30. 5. W. lon. This town consists of about 500 houses, has a weekly market on the Tuesdays, and another on the Fridays; and three fairs for horses, sheep, and black cattle.

**ABERMURDER**, an old law-term for murder, proved in a judicial manner, which could not be atoned for with money.

**ABERRATION**, in astronomy, a small apparent motion of the fixed stars, first discovered by Dr Bradley

and Mr Mollineux, and found to be owing to the progressive motion of light, and the earth's annual motion in its orbit. If a fixed object be fixed, and the eye of the observer moving along in any other direction than that of a straight line from the eye to the object, it is plain, that the object must have an apparent motion, greater or less, according to the velocity with which the eye is moved, and the distance of the object from the eye. See **ASTRONOMY**.

**ABERRATION**, in optics, a deviation of the rays of light, which prevents their coming in the same focal point, and is occasioned by their being refracted by a spherical lens, or reflected by a spherical speculum. See **OPTICS**.

**ABERYSWITH**, a market-town in Wales, lying 199 miles W. S. W. of London, in 52. 30. N. lat. and 40. 15. W. long.

**ABESTA**, the name of one of the sacred books of the Persian magi, which they ascribe to their great founder Zoroaster. The abesta is a commentary on two others of their religious books called *Zend* and *Pazhd*; the three together including the whole system of the Ignicold, or worshippers of fire.

**ABESTON**, a blundering way of writing Abestus. See **ABESTUS**.

**ABETTOR**, a law-term, implying one who encourages another to the performance of some criminal action, or who is art and part in the performance itself. Treason is the only crime in which abettors are excluded by law, every individual concerned being considered as a principal. It is the same with *art and part* in the Scots law.

**ABEVACUATION**, in medicine, a gentle evacuation. See **EVACUATION**.

**ABEX**, the name of a large tract of land, lying along the west coast of the Red-sea, south of Egypt, subject to the Ottoman Porte.

**ABEYANCE**, in law, the expectancy of an estate. Thus if lands be leased to one person for life, with a reversion to another for years, the remainder for years is an abeyance till the death of the lessee.

**ABHEL**, in botany, an obsolete name of the sabina or savin. See **JUNIPER** and **SABINA**.

**ABIB**, signifying an ear of corn, a name given by the Jews to the first month of their ecclesiastical year, afterwards called *Nisan*. It commenced at the vernal equinox, and, according to the course of the moon, by which their months were regulated, answered to the latter part of our March, and beginning of April.

**ABIDING** by a writing, in Scots law: When a person founds upon a writing alleged to be false, he may be obliged to declare judicially, whether he will stand or abide by it as a true deed. As to the consequences of abiding by, or passing from, a false deed, see **SCOTS LAW**, title, *Crimes*.

**ABIES**, the fir-tree, is botany, belongs to the monœcia monadelphia class of Linnæus. For its characters, see **PINUS**, of which it is a species.

**ABIGEAT**, an old law-term, denoting the crime of stealing cattle by droves or herds. This crime was more severely punished than *furtum*, the delinquent being

being often condemned to the mines, banishment, and sometimes capitally.

**ABIGEATUS**, or **ABACTUS**, among physicians, signifies a miscarriage effected by art.

**ABIGIES**, a term in the Roman law, applied to one who had been guilty of the crime **ABIGEAR**; which see.

**ABILITY**, a term in law, denoting a power of doing certain actions in the acquisition or transferring of property.

**ABINGDON**, a town of Berkshire, England, seated on the Thames, about 55 miles W. of London, and gives title of Earl to the noble family of Bertie.

**AB-INTESTATE**, in the civil law, is applied to a person who inherits the right of one who died intestate, or without making a will. See **INTESTATE**.

**ABISHERING**, a term found in old law books, denoting a liberty or freedom from all americiaments, and a right to exact forfeitures of others.

**ABIT**, or **ABOIT**, obsolete terms for ceruse or white lead. See **CERUSE** and **CHEMISTRY**.

**ABJURATION**, in our ancient customs, implied an oath, taken by a person guilty of felony, and who had fled to a place of sanctuary, whereby he solemnly engaged to leave the kingdom for ever.

**ABJURATION**, is now used to signify the renouncing, disclaiming, and denying, upon oath, the Pretender to have any kind of right to the crown of these kingdoms.

**ABJURATION of heresy**, the solemn recantation of any doctrine as false and wicked.

**ABLAC**, a small river in Swabia, which falls into the Danube not far from Furstenburg.

**ABLACTATION**, the weaning a child from the breast. See **WEANING**.

**ABLACTATION**, in gardening, signifies grafting by approach. See **GRAFTING** and **GARDENING**.

**ABLACQUEATION**, an old term in gardening, signifies the operations of removing the earth and baring the roots of trees in winter, to expose them more freely to the air, rain, snows, &c.

**ABLATIVE**, is the 6th case in Latin grammar, and peculiar to that language. It is opposed to the dative, which expresses the action of *giving*, and the ablative that of *taking away*.

**ABLAY**, or **ABLAI**, a country of Great Tartary, whose inhabitants, called *Bochars*, are vassals of the Russians. It lies to the east of the Irtsi, and extends 500 leagues along the southern frontiers of Siberia.

**ABLECTI**, in Roman antiquity, a select body of soldiers chosen from among those called **EXTRAORDINARIJ**, which see.

**ABLEGMINA**, among the ancient Romans, signified those parts in the intrails of victims which were sprinkled with flour, and burnt upon the altar, in sacrificing to the gods.

**ABLET**, or **ABLEN**, an obsolete name of the fish called *Cyprinus*. See **CYPRINUS**.

**ABLUENTS**, in medicine, are the same with diluters.

**ABLUTION**, a ceremony used by the ancient Romans before they began the sacrifice, which consisted in washing the body. They very probably learned this ceremony from the Jews, as have also the Mahometans, who still practise it with the utmost strictness.

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**ABLUTION**, among chemists, the sweetening any matter impregnated with salts, by repeatedly washing it with pure water. See **CHEMISTRY**.

**ABLUTION**, with physicians, is either the washing of any external part by bathing, or of the stomach and intestines by diluting liquors.

**ABO**, a city of Sweden, capital of Finland, seated at the mouth of the river Aurojoks on the gulph of Bothnia, 24. 0. N. E. of Stockholm, in lat. 60. 30. N. and long. 21. 30. E.

**ABOARD**, signifies any part on the deck or inside of a ship; hence any person who goes on the deck, or into the apartments of a ship, is said to go aboard.

**ABOLITION**, implies the act of annulling, destroying, making void, or reducing to nothing. In law, it signifies the repealing any law or statute.

**ABOLLA**, the name of a military garment worn by the Greeks and Romans.

**ABOMASUS**, or **ABOMASUM**, or **ABOMASIUS**, names of the fourth stomach of ruminating animals. The first stomach is called *venter*, the second *reticulum*, the third *omasus*, and the fourth *abomasus*. The third stomach, omasus, is endued with the singular quality of curdling milk. But the truth is, the stomachs of almost all animals, whether they ruminate or not, will produce the same effect, though not perhaps in an equal degree, as the stomachs of calves or lambs. See **MILK**, **RUNNET**.

**ABOMINATION**, a term used in scripture to express idols, idolatry, &c.

**ABORIGINES**, an epithet applied to the original or first inhabitants of any country, but particularly used to signify the ancient inhabitants of Latium, or country now called *Campagna di Roma*, when Æneas with his Trojans came into Italy.

**ABORTION**, in midwifery, the birth of a fœtus before it has acquired a sufficient degree of perfection to enable it to perform respiration and the other vital functions. See **MIDWIFERY**, title, *Of abortions*.

**ABORTION**, among gardeners, signifies such fruits as, being produced too easy, never arrive at maturity.

**ABORTIVE**, in a general sense, implies any thing which comes before its proper time, or miscarries in the execution.

**ABOY**, a small town in Ireland, in the province of Leinster.

**ABRA**, a silver coin of Poland, in value nearly equivalent to an English shilling.

**ABRACADABRA**, a magical word or spell, which being written as many times as the word contains letters, and omitting the last letter of the former every time, was, in the ages of ignorance and superstition, worn about the neck, as an antidote against agues and several other diseases.

**ABRAHAM'S balm**, in botany, See **CANNABIS**.

**ABRAHAMITES**, an order of monks exterminated for idolatry by Theophilus in the ninth century. Also the name of another sect of heretics who had adopted the errors of Paulus. See **PAULICIANS**.

**ABRAMIS**, an obsolete name for the fish *cyprinus*. See **CYPRINUS**.

† B

ABRASA,

**ABRASA**, in surgery, ulcers, where the skin is so tender and lax as to render them subject to abrasion.

**ABRASION**, in medicine, the corroding of any part by acrid humours or medicines.

**ABRAUM**, an obsolete name of a certain species of clay, called by some authors *Adamic earth*, on account of its red colour.

**ABRASAX**, or **ABRAXAS**, a mystical term found in the ancient theology and philosophy of Basilides's followers.

**ABRAX**, an antique stone with the word *abraxas* engraved on it. They are of various sizes, and most of them as old as the third century.

**ABREAST**, a sea-term. In an attack, pursuit, or retreat at sea, the squadrons or divisions of a fleet are often obliged to vary their dispositions, and at the same time observe a proper regularity, by sailing in right or curved lines: when they fail at a proper distance from each other, and are all equally forward, they are then said to have formed the line *abreast*.

**ABRENUNCIATION**. See **RENUNCIATION**.

**ABRIDGEMENT**, in literature, a term signifying the reduction of a book into a smaller compass.—The art of conveying much sentiment in few words, is the happiest talent an author can be possessed of. This talent is peculiarly necessary in the present state of literature; for many writers have acquired the dexterity of spreading a few trititious thoughts over several hundred pages. When an author hits upon a thought that pleases him, he is apt to dwell upon it, to view it in different lights, to force it in improperly, or upon the slightest relations. Though this may be pleasant to the writer, it tires and vexes the reader. There is another great source of diffusion in composition. It is a capital object with an author, whatever be the subject, to give vent to all his best thoughts. When he finds a proper place for any of them, he is peculiarly happy. But, rather than sacrifice a thought he is fond of, he forces it in by way of digression, or superfluous illustration. If none of these expedients answer his purpose, he has recourse to the margin, a very convenient apartment for all manner of pedantry and impertinence. There is not an author, however correct, but is more or less faulty in this respect. An abridger, however, is not subject to these temptations. The thoughts are not his own; he views them in a cooler and less affectionate manner; he discovers an impropriety in some, a vanity in others, and a want of utility in many. His business, therefore, is to retrench superfluities, digressions, quotations, pedantry, &c. and to lay before the public only what is really useful. This is by no means an easy employment: To abridge some books, requires talents equal, if not superiour, to those of the author. The facts, manner, spirit, and reasoning, must be preserved; nothing essential, either in argument or illustration, ought to be omitted. The difficulty of the task is the principal reason why we have so few good abridgements: Wynne's abridgement of Locke's *Essay on the Human Understanding* is, perhaps, the only unexceptionable one in our language.

These observations relate solely to such abridgements as are designed for the public. But,

When a person wants to set down the substance of any book, a shorter and less laborious method may be followed. It would be foreign to our plan to give examples of abridgements for the public: But, as it may be useful, especially to young people, to know how to abridge books for their own use, after giving a few directions, we shall exhibit an example or two, to shew with what ease it may be done.

Read the book carefully; endeavour to learn the principal view of the author; attend to the arguments employed: When you have done so, you will generally find, that what the author uses as new or additional arguments, are in reality only collateral ones, or extensions of the principal argument. Take a piece of paper, or a common-place book, put down what the author wants to prove, subjoin the argument or arguments, and you have the substance of the book in a few lines. For example,

In the *Essay on Miracles*, Mr Hume's design is to prove, That miracles which have not been the immediate objects of our senses, cannot reasonably be believed upon the testimony of others.

Now, his argument, (for there happens to be but one), is,

“ That experience, which in some things is variable, in others uniform, is our *only* guide in reasoning concerning matters of fact. A variable experience gives rise to probability only; an uniform experience amounts to a proof. Our belief of any fact from the testimony of eye-witnesses, is derived from no other principle than our experience in the veracity of human testimony. If the fact attested be miraculous, here arises a contest of two opposite experiences, or proof against proof. Now, a miracle is a violation of the laws of nature; and as a firm and unalterable experience has established these laws, the proof against a miracle, from the very nature of the fact, is as complete as any argument from experience can possibly be imagined; and if so, it is an undeniable consequence, that it cannot be surmounted by any proof whatever derived from human testimony.”

In *Dr Campbell's Dissertation on Miracles*, the author's principal aim is to shew the fallacy of Mr Hume's argument; which he has done most successfully by another single argument, as follows:

“ The evidence arising from human testimony is *not solely* derived from experience: on the contrary, testimony hath a natural influence on belief antecedent to experience. The early and unlimited assent given to testimony by children gradually contracts as they advance in life: it is, therefore, more consonant to truth, to say, that our *diffidence* in testimony is the result of experience, than that our *faith* in it has this foundation. Besides, the uniformity of experience, in favour of any fact, is not a proof against its being reversed in a particular instance. The evidence arising from the single testimony of a man of known veracity will go far to

“ establish

“ establish a belief in its being actually reversed: If his testimony be confirmed by a few others of the same character, we cannot withhold our assent to the truth of it. Now, though the operations of nature are governed by uniform laws, and though we have not the testimony of our senses in favour of any violation of them, still, if, in particular instances, we have the testimony of thousands of our fellow-creatures, and those too men of strict integrity, swayed by no motives of ambition or interest, and governed by the principles of common sense, That they were actually eye-witnesses of these violations, the constitution of our nature obliges us to believe them.”

These two examples contain the substance of about 400 pages.—Making private abridgements of this kind has many advantages; it engages us to read with accuracy and attention; it fixes the subject in our minds; and, if we should happen to forget, instead of reading the books again, by glancing a few lines, we are not only in possession of the chief arguments, but recall in a good measure the author's method and manner.

Abridging is peculiarly useful in taking the substance of what is delivered by Professors, &c. It is impossible, even with the assistance of short-hand, to take down, *verbatim*, what is said by a public speaker. Besides, although it were practicable, such a talent would be of little use. Every public speaker has circumlocutions, redundancies, lumber, which deserve not to be copied. All that is really useful may be comprehended in a short compass. If the plan of the discourse, and arguments employed in support of the different branches be taken down, you have the whole. These you may afterwards extend in the form of a discourse dressed in your own language. This would not only be a more rational employment, but would likewise be an excellent method of improving young men in composition, an object too little attended to in all our universities. Besides, it would be more for the honour of professors; as it would prevent at least such immense loads of disjointed and unintelligible rubbish from being handed about by the name of such a man's lectures.

**AWARDMENT**, in law, signifies the making a declaration or plaint shorter by leaving out something

**ABRIDGEMENT**, in arithmetic. See **ARITHMETIC**, *Of vulgar fractions*

**ABRIDGEMENT**, in algebra. See **ALGEBRA**, *Of equations*

**ABROBANIA**, a town and district in Transylvania.

**ABROCHMENT**, an old law term which signifies forestalling. See **FORESTALLING**.

**ABROGATION**, signifies annulling, making void, or repealing a law.

**ABROLKOS**, the name of certain shelves, or banks of sand, about 20 leagues from the coast of Brazil.

**ABRON**, a river of France which falls into the Loire not far from Nevers.

**ABRONO**. See **ABRUGI**.

**ABROTANOIDES**, the name of a species of coral called

*porus*. It is also a synonyme of the artemisia. See **ARTEMISIA**.

**ABROTANOIDES**, a wine mentioned by Dioscorides, impregnated with futhernwood.

**ABROTANUM**, in botany, a synonyme of several plants. See **ARTEMISIA**, **FILAGO**, **SANTOLINA**.

**ABRUPTION**, in surgery. See **ABDUCTION**.

**ABRUS**, in botany, the trivial name of the glycine. See **GLYCINE**.

**ABRUZZO**, in geography, the name of two provinces belonging to the K. of Naples, on the gulph of Venice, distinguished by Nearer and Farther Abruzzo, from their position with respect to Naples.

**ABSCEDENTIA**, in surgery, a term applied to decayed parts of the body, which, in a morbid state, are separated from the sound, or lose that union which was preserved in a natural state.

**ABCESS**, in medicine and surgery, an imposthume, or any tumor or cavity containing purulent matter. See **SURGERY**, title, *Of tumours or abscesses*.

**ABSCHARON**, a town in Asia, situated on the western shore of the Caspian sea.

**ABSCISSE**, in mathematics. See **CONIC SECTIONS**.

**ABSCISSION**, a figure in rhetoric, whereby the speaker stops short in the middle of his discourse, leaving the audience to make the inference.

**ABSCISSION**, in surgery, the same with amputation.

**ABSCONSA**, a dark lantern used by the monks at the ceremony of burying their dead.

**ABSENCE**, in Scots law: When a person cited before a court does not appear, and judgment is pronounced, that judgment is said to be *in absence*. No person can be tried criminally in absence. See **LAW**, title, *Sentences and their execution*.

**ABSINTHIATED medicines**, such as are impregnated with absinthium or wormwood.

**ABSINTHIUM**, in botany, the trivial name of the common wormwood or artemisia. It is also a synonyme of the tanacetum incanum, the fenecio incanum, the anthemis montana, the achillea egyptiaca, and of the parthenium hysterophorus. See **ARTEMISIA**, &c.

**ABSIS**, in astronomy, the same with **APSTIS**, which see.

**ABSOLUTE**, in a general sense, denotes a thing's being independent of, or unconnected with, any other; it is also used to express freedom from all limitation.

**ABSOLUTE government**, is that wherein the prince, unlimited by the laws, is left solely to his own will. See **GOVERNMENT**.

**ABSOLUTE gravity**, in physics, is the whole force by which a body is urged downwards. See **MECHANICS**.

**ABSOLUTE**, in metaphysics, denotes a being that possesses independent existence.

**ABSOLUTION**, in general, is the pardoning or forgiving a guilty person.

**ABSOLUTION**, in civil law, is a sentence whereby the party accused is declared innocent of the crime laid to his charge.

**ABSOLUTION**, in the canon law, is a juridical act whereby the ecclesiastical officers remit or forgive the penitent offender, or declare him restored to the privileges of innocence in consideration of his repentance.

**ABSORBENT**

**ABSORBENT** *medicines*, testaceous powders, as chalk, crabs-eyes, &c. which are taken inwardly for drying up or absorbing any acrid or redundant humours in the stomach or intestines. They are likewise applied outwardly to ulcers or sores with the same intention.

**ABSORBENT vessels**, in anatomy, a name given promiscuously to the lacteal vessels, lymphatics, and inhalent arteries. See **ANATOMY**.

**ABSORBENT vessels**, is also a name used for the small fibrous roots of plants.

**ABSORPTION**, in the animal economy, is the act whereby the absorbent vessels imbibe the juices, &c.

**ABSTEMIOUS**, an epithet applied to persons very temperate in eating and drinking. It is likewise applied to those who could not partake of the eucharist on account of their aversion to wine.

**ABSTENTUS**, in law, an heir who is withheld by his tutor from entering upon his inheritance.

**ABSTERGENT** *medicines*, those employed for resolving obstructions, concretions, &c. such as soap, &c.

**ABSTINENCE**, the refraining from something we have a propensity to. It commonly imports a spare diet.

**ABSTINENTS**, in church history, a sort of people in the ancient church who carried their abstinence and mortification very far. They have been classed with heretics, though we have no certain account of their particular opinions.

**ABSTRACT** *idea*, in metaphysics, is a partial idea of a complex object, limited to one or more of the component parts or properties, laying aside or abstracting from the rest. Thus, in viewing an object with the eye, or recollecting it in the mind, we can easily abstract from some of its parts or properties, and attach ourselves to others: we can attend to the redness of a cherry, without regard to its figure, taste, or consistence. See **ABSTRACTION**, **METAPHYSICS**.

**ABSTRACT** *terms*, words that are used to express abstract ideas. Thus beauty, ugliness, whiteness, roundness, life, death, are abstract terms.

**ABSTRACT** *mathematics*, sometimes denominated *pure mathematics*, treat of magnitude or quantity absolutely and generally considered, without regard to any particular species of magnitude.

**ABSTRACT** *numbers*, such as have no particular application.

**ABSTRACT**, is also a term in literature to signify a concise, yet general view or analysis of some larger work. It differs from an abridgment, in being shorter and more superficial; and from an extract, as this last is a copy of some part or passage of it.

**ABSTRACTION**, the operation of the mind when occupied by abstract ideas. A large oak fixes our attention, and abstracts us from the shrubs that surround it. In the same manner, a beautiful woman in a crowd, abstracts our thoughts, and engrosses our attention solely to herself. These are examples of real abstraction: when these, or any others of a similar kind, are recalled to the mind, after the objects themselves are removed from our sight, they form what is called *abstract ideas*, or the mind is said to be employed in abstract ideas. But the power of abstraction is not confined to ob-

jects that are separable in reality as well as mentally: the size, the figure, the colour of a tree are inseparably connected, and cannot exist independent of each other; and yet we can mentally confine our observations to any one of these properties, neglecting or abstracting from the rest.

**ABSTRACTION**, in chemistry, the evaporating or drawing off the menstruum from any subject.

**ABSTRACTITIOUS**, an obsolete term, among chemists, for a vegetable spirit obtained without fermentation.

**ABTRUSE**, a term applied to any thing that is hard to be understood, whether the obscurity arises from the difficulty of the subject, or the confused manner of the writer.

**ABSURD**, an epithet for any thing that contradicts an apparent truth.

**ABSURDITY**, the name of an absurd action or sentiment.

**ABSUS**, in botany, the trivial name of a species of the cassia.

**ABSINTHIUM**. See **ABSINTHIUM**.

**ABUAI**, one of the Philippine isles. See **PHILIPPINE**.

**ABUCCO**, **ABOCCO**, or **ABOCCI**, a weight used in the kingdom of Pegu, equal to 12½ tēccalis; two abuccos make an agiro; and two agiri make half a bizza, which is equal to 2 lb 5 oz. of the heavy weight of Venice.

**ABUKESO**. See **ASLANI**.

**ABUNA**, the title of the Archbishop or Metropolitan of Abyssinia.

**ABUNDANT** *numbers*, such whose aliquot parts added together exceed the number itself; as 20, the aliquot parts of which are, 1, 2, 4, 5, 10, and make 22.

**ABUSAN**, an island on the coast of Africa, in 35. 35. N lat. dependent on the province of Garet, in the kingdom of Fez.

**ABUSE**, implies the perverting of any thing from its original intention.

**ABUTIGE**, a town in Upper Egypt, famous for producing the best opium.

**ABUTTALS**. See **ABUTTALS**.

**ABUTILON**, in botany, the trivial name of several species of the sida. See **SIDA**. Abutilon is also a synonyme of the melochia tomentosa, and melochia depressa, two American plants of the monadelphia pentandria class. It is likewise a synonyme of the lavatera, malva, and hibiscus.

**ABYSS**, in a general sense, signifies any unfathomable gulph. It is also the name of a vast cavern filled with water, supposed to exist near the centre of the earth.

**ABYSS**, in scripture, is sometimes used for hell.

**ABYSS**, in antiquity, a name given to the temple of Proserpine,

**ABYSS**, among alchemists, signifies the receptacle of the feminal matter, and sometimes the feminal matter itself.

**ABYSSINIA**, a kingdom of Africa, bounded on the N. by that of Sennar, or Nubia; on the E. partly by the Red sea, and partly by Danacala; on the W. by Gorham and Gingiro; and on the S. by Alaba and Ommo-Zaidi. It was formerly of greater extent



extent than it is at present, because several provinces have revolted, and the Turks have made encroachments to the east. The land is fertile in many places, and the air is very hot, except in the rainy season, and then it is very temperate. For four months in the year, greater rains fall there than perhaps in any other part of the world, which occasion the swelling of the river Nile, that has its source in this country. It contains mines of all sorts of metal, except tin; but the inhabitants make no great advantage thereof. The fields are watered by several streams, except in the mountainous parts. The emperor, or king, is called *Negus*; and he has been commonly taken for Prester John. His authority is absolute, and he often dwells with his whole court in tents. However, Abyssinia is not without cities, as some pretend; for Gondar is a large place, where the king commonly resides when he is not in the field. The inhabitants are black, or very near it; but they are not so ugly as the negroes. They make profession of the Christian religion, but it has a mixture of Judaism. The habit of persons of quality is a silken vest, with a sort of scarf; but the common people wear nothing but a pair of drawers.

**ABYSSINIAN church**, that established in the empire of Abyssinia. It is a branch of the Copts or Jacobites, a sect of heretics, who admit but one nature in Jesus Christ.

**ACACALOTL**, the Brasilian name of a species of the *Corvus*. See *CORVUS*.

**ACACIA**, in botany, a synonyme of the poinciana, genista, mimosa, robinia, guaicum, &c. See these articles.

**ACACIA**, in the materia medica, the inspissated juice of the unripe fruit of the acacia. This juice is brought from Egypt in roundish pieces, wrapt up in thin bladders, and is used as a mild astringent.

**ACACIA germanica**. See *PRUNA*.

**ACACIA**, among antiquaries, something resembling a roll or bag, seen on medals, as in the hands of several consuls and emperors. Some take it to represent a handkerchief rolled up, wherewith they made signals at the games; others a roll of petitions or memorials; and some a purple bag full of earth, to remind them of their mortality.

**ACACIANS**, in ecclesiastical history, the name of several sects of heretics; some of whom maintained, that the Son was only a similar, not the same, substance with the Father; and others, that he was not only a distinct, but a dissimilar substance. Two of these sects had their denomination from Acacius bishop of Casarea, who lived in the fourth century, and changed his opinions, so as, at different times, to be head of both. Another was named from Acacius patriarch of Constantinople, who lived in the close of the fifth century.

**ACADEMIC**, **ACADEMICIAN**, or **ACADEMIST**, a member of an academy. See *ACADEMY* in the modern sense.

**ACADEMICS**, or **ACADEMISTS**, a denomination given to the cultivators of a species of philosophy originally derived from Socrates, and afterwards illustrated

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and enforced by Plato, who taught in a grove near Athens, consecrated to the memory of Academus an Athenian hero; from which circumstance this philosophy received the name of *academical*. Before the days of Plato, philosophy had, in a great measure, fallen into contempt. The contradictory systems and hypotheses that had successively been urged upon the world, were become so numerous, that, from a view of this inconsistency and uncertainty of human opinions, many were led to conclude, that truth lay beyond the reach of our comprehension. Absolute and universal scepticism was the natural consequence of this conclusion. In order to remedy this abuse of philosophy and of the human faculties, Plato laid hold of the principles of the academical philosophy, and, in his *Phædo*, reasons in the following manner: "If we are unable to discover truth, (says he), it must be owing to two circumstances; either there is no truth in the nature of things, or the mind, from a defect in its powers, is not able to apprehend it. Upon the latter supposition, all the uncertainty and fluctuation in the opinions and judgments of mankind admit of an easy solution: Let us therefore be modest, and ascribe our errors to the real weakness of our own minds, and not to the nature of things themselves. Truth is often difficult of access: in order to come at it, we must proceed with caution and diffidence, carefully examining every step; and after all our labour, we will frequently find our greatest efforts disappointed, and be obliged to confess our ignorance and weakness."

Labour and caution in our researches, in opposition to rash and hasty decisions, were the distinguishing characteristics of the disciples of the ancient academy. A philosopher possessed of these principles, will be slow in his progress, but will seldom fall into errors, or have occasion to alter his opinion after it is once formed. Vanity and precipitance are the great forces of scepticism: hurried on by these, instead of attending to the cool and deliberate principles recommended by the academy, several of our modern philosophers have plunged themselves into an absurd and ridiculous kind of scepticism. They pretend to discredit things that are plain, simple, and easily comprehended; but give peremptory and decisive judgments upon subjects that evidently exceed the limits of our capacity. Of these Berkley and Hume are the most considerable. Berkley denied the existence of every thing, excepting his own ideas. Mr Hume has gone a step further, and questioned even the existence of ideas; but at the same time has not hesitated to give determined opinions with regard to eternity, providence, and a future state, miraculous interpositions of the Deity, &c. subjects far above the reach of our faculties. In his essay on the academical or sceptical philosophy, he has confounded two very opposite species of philosophy. After the days of Plato, indeed, the principles of the first academy were grossly corrupted by Arcefilas, Carneades, &c. This might lead Mr Hume into the notion that the *academical* and *sceptical* philosophy were synonymous terms. But no principles can be of a more opposite nature than

than those which were inculcated by the old academy of Socrates and Plato, and the sceptical notions which were propagated by Arcefilas, Carneades, and the other disciples of the succeeding academics.

**ACADEMY**, in antiquity, a garden or villa, situated within a mile of Athens, where Plato and his followers held their philosophical conferences. It took its name from one Academus, or Ecademus, a citizen of Athens, who was the original owner of it, and made it a kind of gymnasium: he lived in the time of Theseus. Cimon embellished it with fountains, trees, and walks; but Sylla, during the siege of Athens, employed these very trees in making battering-engines against the city. Cicero too had his villa, or place of retirement, near Puzzuoli, which he also named an academy, where he composed his *Academical questions*, and his book *De natura deorum*.

**ACADEMY**, among the moderns, is most commonly used to signify a society of learned men, established for the improvement of any art or science. Charlemagne was the first that established an academy in Europe. Most nations have since followed his example; but Italy has by far the greatest number. In the cities of Piedmont, Ferrara, and Milan, Jarckius reckons 550. We have but few in Britain. In England those of note are, the Royal Society, the Antiquarian Society, Society for the encouragement of arts, and the Academy of Painting; in Scotland, the Edinburgh Society, College of Physicians, and Musical Society; all which see in their proper places.

The French have several academies; as, the Royal Academy of Sciences, for the improvement of physics, mathematics, and chemistry. It was first instituted in 1666, by the assistance of Mr Colbert, comptroller-general of the finances, but was not confirmed by the French king till the year 1696, who, by a regulation dated the 26th of January, new-modelled and put it on a better footing. According to this regulation, the academy was to be composed of ten honorary academicians, eight strangers associates, twenty pensionaries fellows, twenty elevés or scholars, and twelve French associates; these were to be divided into six classes, *viz.* geometricians, astronomers, mechanics, anatomists, chemists, and botanists; the honorary academicians to be all inhabitants of France, the pensionaries and elevés all to reside at Paris.

In the year 1716, the duke of Orleans, then regent, made an alteration in their constitution, augmenting the number of honoraries and associates to twelve, admitting regulars among such associates, suppressing the class of elevés, and establishing in lieu thereof a new class of twelve adjuncts to the six several kinds of science cultivated by the academy; and, lastly, appointing a vice-president, to be chosen yearly by the king out of the honorary members, and a director and sub-director out of the pensionaries.

The academies of Florence and Bologne, of Montpellier and Bourdeaux, of Leipzig and Berlin, and of late those of Petersburg and Seville, were formed upon the same model with the Royal Academy of Sciences.

**French ACADEMY**, a society of forty, established for improving the French language.

This academy was founded by Cardinal Richlieu, and confirmed by the edict of Lewis XIII. in 1635. They have compiled a dictionary, intitled, *Le Dictionnaire de l'academie Françoise*. This work was begun in 1637, and finished in 1694. They have a director and chancellor, who are drawn by lot every three months, and a secretary who is perpetual. They meet at the old Louvre, on the Mondays, Thursdays, and Saturdays, all the year round, and hold an extraordinary meeting at the reception of a new member, and on St Lewis's day, when the prizes of eloquence and poetry are adjudged.

**Royal ACADEMY of Painting and Sculpture**. This society was founded about the year 1648. The members were at first about twenty-five in number, *viz.* twelve officers, called *ancients*, eleven private members, and two syndics; but at present it consists of forty painters and sculptors. There are four perpetual rectors, nominated by the king; a director and chancellor; a secretary, who keeps the register, and countersigns the dispatches; a treasurer, twelve professors, adjuncts to the rectors and professors, six counsellors, a professor for the part of anatomy that belongs to painting and sculpture, and another for geometry and perspective.

There is also an academy of painting, sculpture, &c. at Rome, established by Lewis XIV. wherein those who have won the annual prize at Paris, are entitled to be three years entertained for their further improvement.

**ACADEMY of Medals and Inscriptions**, called also *The academy of belles lettres*, was erected by Lewis XIV. for the study and explanation of ancient monuments, and to perpetuate the remembrance of great events, by medals, relievos, inscriptions, &c. The plan of this academy was formed by Mr Colbert, and established in 1663. In its first institution it consisted only of four or five members; but in 1701, they were increased to forty, *viz.* ten honoraries, ten pensionaries, ten associates, and ten novices or elevés, under the direction of a president and vice-president, who are annually appointed by the king.

Their chief employment has been upon the medallic history of the reign of Lewis their founder. But the learned are indebted to this academy for many volumes of essays on other parts of history, published under the title of *Memoirs*, &c.

**ACADEMY of Architecture**, established about the end of the year 1671 by Mr Colbert, consisted at first only of six architects; but their number is since considerably increased.

**ACADEMY of Politics**, is composed of six persons, who meet at the Louvre, in the chamber where the papers relating to foreign affairs are lodged. But as the kings of France are unwilling to trust any, except their ministers, with the inspection of foreign affairs, this academy is of little use to the public.

**Royal ACADEMY of Dancing** was established by the King of France in 1661. It consists of thirteen dancing-masters,

masters, who meet once a-month; and two of the academists teach by turns the art of dancing, ancient and modern.

The French have also academies in most of their great cities, as, the Academy of Sciences at Montpellier, that of the Lanternists at Thoulouse; besides others at Nismes, Arles, Angiers, Lyons, Caen in Normandy, &c.; and the Chirurgical Academy at Paris is a modern institution for the general improvement of the art, and to compile and publish the ancient and modern history of it.

**Royal Spanish ACADEMY** at Madrid, has for its object the cultivation of the Castilian tongue, and was established in 1714 by the Duke d'Escalona, with the approbation of the King of Spain. It consists of twenty-four academists, including the director and secretary.

In Portugal, John V. founded an historical academy at Lisbon, in the year 1720, for collecting and ascertaining the history of his own dominions. It consists of fifty members, a director, four censors, and a secretary.

In Germany, they have the Academy of *Natura Curiosi*, otherwise called the *Leopoldine Academy*, founded in 1652 by Jo. Laur. Baufch a physician, and, in 1670, taken under the protection of the Emperor Leopold. The design of this society was to promote medical knowledge. They began in 1684 to publish their observations, under the title of *Ephemérides*; which publication has been continued annually, with some interruptions, and under different titles. This academy consists of a president, two adjuncts or secretaries, and colleagues or members without limitation.

**Berlin ACADEMY**, was founded by Frederick I. the late King of Prussia, in the year 1700. It has for its objects the improvement of natural knowledge, and the belles lettres. The charter of this society was amended in 1710, and by it the president is to be nominated by the king. The members are divided into four classes; 1. for physic, medicine, and chemistry; 2. for mathematics, astronomy, and mechanics; 3. for the German language, and the history of the country; 4. for Oriental learning, particularly what relates to the propagation of the gospel among infidels. The great promoter of this foundation was the celebrated Mr Leibnitz.

**Russian ACADEMY** was founded by Czar Peter the Great, at Petersburg, upon the plan of the Academy of Sciences at Paris; besides which, they take in the Russian language.

**ACADEMY** is also a term for schools and other seminaries of learning among the Jews, where their rabbins and doctors instructed their youth in the Hebrew language, and explained to them the Talmud, and the secrets of the Cabbala: Those of Tiberias and Babylon have been the most noted.

**ACADEMY** is often used with us to denote a kind of collegiate school, where youth are instructed in arts and sciences. There is one at Portsmouth for teaching navigation, drawing, &c.; another at Woolwich, for fortification, gunnery, &c.

**ACADEMY** is likewise a name given to a riding-school, where young gentlemen are taught to ride the great horse, &c. and the ground allotted for it is usually called the *Menage*.

**ACADEMY figure**, a drawing of a naked man or woman, taken from the life, which is usually done on paper with red or black chalk, and sometimes with pastils or crayons.

**ACADIE**, or **ACADIA**, in geography, a name formerly given to Nova Scotia, one of our American colonies. See **NOVA SCOTIA**.

**ACÆNA**, in antiquity, a Grecian measure of length, being a ten feet rod, used in measuring their lands.

**ACAIABA**. See **ACAJOU**.

**ACAJA**, in botany, a synonyme of the *spondias lutea*, an American tree. See **SPONDIAS**.

**ACAJOU**, in botany, a synonyme of the *anacardium occidentale*, or cashew-nut-tree. See **ANACARDIUM**.

**ACALEPTIC**, in ancient prosody, a complete verse.

**ACALIS**, in botany, an obsolete name of the *Ceratonia*. See **CERATONIA**.

**ACALYPHA**, in botany, a genus of plants belonging to the monœcia monadelphia class. There are only four species of this plant; the *acalypha virginica*, which is a native of Ceylon; the *virgata*, *indica*, and *australis*, all natives of America. Sir Hans Sloan ranks this plant with the nettle, under the name of *urtica minor iners spicata*.

**ACAMATOS**, a word used to express the best shape of the human body.

**ACAMBOU**, a kingdom on the coast of Guinea in Africa.

**ACAMEEH**, among some of the old chemists, the scoræ of silver; as also a superfluity of the humidum radicale.

**ACANACEOUS plants**, such as are armed with prickles.

**ACANAPHORA**, in botany, an obsolete name of the *centaurea jacea*, or knapweed. See **CENTAUREA**.

**ACANES**, in geography. See **AKANIS**.

**ACANGIS**, that is, *ravagers* or *adventurers*; a name which the Turks give their hussars or light-troops, who are generally sent out in detachments to procure intelligence, harass the enemy, or ravage the country.

**ACANNY**, an inland country on the gold coast of Guinea in Africa, which affords the best gold, and in great plenty. There is a town or village of the same name, W. long. 0. 5. lat. 8. 30.

**ACANTHA**, in botany, the prickle of any plant.

**ACANTHA**, in zoology, a term for the spine or prickly fins of fishes.

**ACANTHA**, in anatomy, an obsolete term for the spinal processes of the back.

**ACANTHABOLUS**, in surgery, an instrument for pulling thorns, or the like, out of the skin.

**ACANTHACEOUS**, among ancient botanists, an epithet given to thistles and other prickly plants.

**ACANTHE**, in botany, an obsolete name for the *Cynara* or artichok. See **CYNARA**.

**ACANTHIAS**, in ichthyology, the trivial name of a species of *squalus*. See **SQUALUS**.

ACAN-

**ACANTHINE**, any thing resembling or belonging to the herb acanthus. Acanthine garments, among the ancients, are said to be made of the down of thistles; others think they were garments embroidered in imitation of the acanthus.

**ACANTHIUM**, in botany, the trivial name of a species of onopordum. See **ONOPORDUM**.

**ACANTHOIDES**, in botany, a synonyme of the carlina, or carline-thistle. See **CARLINA**.

**ACANTHOPTERYGIUS** fishes, a term used by Linnæus and others for those fishes whose back-fins are hard, osseous, and prickly.

**ACANTHUS**, bears-breach, or brank-urline, in botany, a genus of plants belonging to the didynamia angiospermia class. There are only five species of this plant, all of which are natives either of Italy or the Indies. For its figure, which is extremely beautiful, see plate I. fig. 3. The leaves of the acanthus are famous for having given rise to the capital of the Corinthian order of architecture.

**ACANTHUS** is likewise used by Theophrastus as a synonyme of the acacia.

**ACANTHUS**, in architecture, an ornament representing the leaves of the acanthus, used in the capitals of the Corinthian and Composite orders. See **ARCHITECTURE**.

**ACANUS**, in botany, a synonyme of the carduus cabaonæ of Linnæus. See **CARDUUS**.

**ACAPATLI**, the American name of the piper longum, or long pepper. See **PIPER**.

**ACAPNON**, in botany, an obsolete name of the origanum or marjoram. See **ORIGANUM**.

**ACAPULCO**, in geography, a sea-port town in North America, in 102. o. W. long. 17. 3. N. lat. situated in the province of Mexico, on a fine bay of the South-sea, from whence a ship sails annually to Manilla in the Philippine islands.

**ACARA**, in ichthyology, an obsolete name of the perca chrysoptera. See **PERCA**.

**ACARA-AYA**, in ichthyology, an obsolete name of a species of the cyprinus or carp. See **CYPRINUS**.

**ACARA-PEBA**, in ichthyology, an obsolete name of the sparus. See **SPARUS**.

**ACARA-PINIMA**, in ichthyology, an obsolete name of the sparus cantharus. See **SPARUS**.

**ACARA-PITAMBA**, in ichthyology, an obsolete name of a species of the mugil. See **MUGIL**.

**ACARAI**, a town in Paraguay in South America, built by the Jesuits in 1624, 116. 40. long. 26. o. S. lat.

**ACARI**. See **ACARUS**.

**ACARICOBIA**, in botany, a synonyme of the hydrocotyle umbellata. See **HYDROCOTYLE**.

**ACARNA**, in botany, a synonyme of the carduus cabaonæ, of the cnicus, of the carlina lanata, corymbosa, racemosa, and cancellata. *Acarna* is also used by Vaillant as a term for cynaracephalous or artichoke-headed plants.

**ACARNAN**, an obsolete name of the sparus erythrinus. See **SPARUS**.

**ACARON**, the name of the god of flies. The Ekronites called him *Baalzebub*.

**ACARUS**, a genus of insects belonging to the order of aptera, or such as have no wings. The acarus has 8 legs, 2 eyes, one on each side of the head, and two jointed tentacula like feet. See plate I. fig. 4. There are thirty-one species of the acarus. 1. The elephantinus, is about the size of a white lupin seed, has a depressed orbicular livid body, thickest at the edges, with three furrows on each side of the belly, and a black oval trisid spot at the base or end of the body. It is a native of India. 2. The ægyptius, is of an oval shape, yellowish colour, and a white edge or margin. It is a native of the East. 3. The reduvius is plain and oval, with an oval spot at the base. It lives on oxen and dogs. 4. The americanus, is reddish and oval, with the scutellum and joints of the feet white. It is a native of America. 5. The sanguifugus. The hinder part of the abdomen is crenated, the scutellum is oval and yellowish, and the beak is trisid. It is a native of America, and sticks so fast on the legs of travellers, sucking their blood, that they can hardly be extracted. 6. The ricinus is globular, and has a round spot at the base; the feelers are clubbed. It inhabits the bodies of dogs and oxen. 7. The cancroides, with nippers like a crab, and an oval depressed belly. It is found in the shady places of Europe. 8. The scorpioides, with crab-like nippers, a cylindrical belly, and a small pendulous head. It is of a yellowish colour; and its bite is venomous. It is a native of America. 9. The crassipes has the second pair of legs shaped like those of a crab, and is a native of Europe. 10. The passerinus has the third pair of legs remarkably thicker than the rest. It infests several species of sparrows. 11. The motatorius has the first pair of legs very long and nimble, and frequents the woods. 12. The aphidioides has the first pair of feet longest, and two small horns at the hinder part of the belly. It is a native of Europe. 13. The coleoptratus is black, and the sides are a little crustaceous. It is a native of Europe. 14. The telarius is of a greenish yellow colour. It has a small sting or weapon, with which it wounds the leaves of plants, and occasions them to fold backward. They are very frequently to be met with in the autumn, inclosed in the folded leaves of the lime-tree. 15. The siro has lob-like sides; the four hinder feet are longest; the head and thighs are of an iron colour, and the belly is bristly. It inhabits the farinaceous plants of Europe and America. 16. The exulcerans has very long setaceous legs, but the two first are short. It inhabits the scabies. 17. The geniculatus, is black, and the joints of the thighs are globular. 18. The aquaticus has a depressed red belly, and the hinder part of it obtuse. It inhabits the fresh waters of Europe. 19. The holosericeus has the same characters with the former, only it does not live in water. 20. The baccharum, has a red distended belly, and lives on gooseberries, &c. 21. The muscorum, is of a yellowish red colour, and the hinder legs are long and thread-like. It inhabits mosses. 22. The batatas, is of a blood-colour, and a little rough; the fore pair of legs are as long as the body.

body. It inhabits the potatoes of Surinam. 23. The *gymnopteronum*, is reddish, with two scarlet spots on each side. It inhabits bees, &c. 24. The *coleopterorum*, is reddish, with a white anus. It inhabits the scarabæus. 25. The *rupestris*, is yellowish, with a double coloured line on the back. It is a native of Europe. 26. The *longicornis*, is red, and the feelers are longer than the snout. It is a native of Europe. 27. The *littoralis*, is of a tawny yellowish colour, and has blood-red legs. It frequents the shores of Europe. 28. The *fungorum* is of a yellowish colour, and has a globular clammy belly. It inhabits the mushroom. 29. The *scaber*, is ash-coloured, and depressed; the sides are scurfy. It is a native of Europe. 30. The *falicinus*, is red, with two yellow lines on the back; it is forked before. It dwells on the willows. 31. The *croceus*, is yellow, with a reddish spot on each side of the breast.

**ACATALECTIC**, a term, in the ancient poetry, for such verses as have all their feet or syllables, in contradistinction to those that have a syllable too few.

**ACATALEPSY**, signifies the impossibility of comprehending any thing.

**ACATALIS**, a name given by the ancients to the juniper-berry.

**ACATASTATOS**, with physicians, signifies the irregular paroxysms of a disease.

**ACATERY**, or **ACCATRY**, an officer of the king's household, designed for a check betwixt the clerks of the kitchen and the purveyors.

**ACATHARSIA**, an impurity of the blood or humours.

**ACATHISTUS**, in an ecclesiastical sense, a solemn hymn anciently sung in the Greek church on the Saturday of the fifth week of Lent, in honour of the Virgin, for having thrice delivered Constantinople from the invasions of the barbarous nations.

**ACATIUM**, in antiquity, a kind of boat used in military affairs, and was a species of the *naves actuariae*. See **ACTUARIÆ NAVES**.

**ACATSIA-VALLI**, in botany, a synonyme of the *castilla filiformis*. See **CASSITHA**.

**ACAULIS**, in botany, signifies plants that have no caulis or stem.

**ACCALIA**, in antiquity, solemn feasts held in honour of *Acca Laurentia*, nurse to Romulus. They were otherwise called *Laurentalia*.—To the same *Acca* is also ascribed the institution of the *fratres arvales*.

**ACCAPITARE**, in law, the act of becoming vassal of a lord, or of yielding him homage and obedience. See **VASSAL** and **HOMAGE**.

**ACCAPITUM**, signifies the money paid by a vassal upon his admission to a feud.

**ACCAPITUM**, in our ancient law, was used also to express the relief due to the chief lord. See **RELIEF**.

**ACCEDAS ad curiam**, in the English law, a writ lying, where a man has received, or fears false judgment, in an inferior court; it lies also for justice delayed, and is a species of the writ *recordare*.

**ACCEDONES**. See **ACCESSIONES**.

**ACCELERATED**, implies, in a general sense, quick-

ened, continually increasing. Thus, *accelerated motion* is a motion continually increasing. See **MECHANICS**.

**ACCELERATION**, an increase of velocity in the motion of a body; it is opposed to retardation, which is a diminution of motion.

**ACCELERATION**, is also a term used by ancient astronomers, with whom it signified the difference between the revolution of the *primum mobile*, and that of the sun, computed to be three minutes and fifty-six seconds.

**ACCELERATOR**, in anatomy, the name of two muscles of the penis, which serve for ejecting the urine or semen. See **ANATOMY**, Part VI.

**ACCIDENTES**, a lower order of ministers in the Romish church, whose office is to light and trim the candles.

**ACCENDONES**, in Roman antiquity, a sort of gladiators, whose office was to excite and animate the combatants during the engagement. See **GLADIATOR**.

**ACCENSI**, among the ancient Romans, a kind of supernumerary soldiers, who served to fill the places of those who were killed or disabled by their wounds.

**ACCENSI serenses**, among the Romans, an inferior order of officers, who attended the magistrates in the manner of our uhlers, serjeants, or tipstaffs.

**ACCENSION**, in chemistry, the action of setting a body on fire: thus the accension of tinder is effected by striking fire with flint and steel.

**ACCENT**, or accenting, in reading or speaking: When we raise the tone higher in sounding any particular word or syllable, that word or syllable is said to be accented, or graced with an accent. In hexameters there is a capital accent in every line, easily distinguishable from the rest by a good ear. Thus,

*Nec bene promeritis capitur, nec tangitur ira.*

Accents either in prose or poetry have a double effect: They contribute to the melody, by giving it air and spirit; they contribute not less to the sense, by distinguishing words of importance from others. Accenting is entirely confined to long syllables; for a short syllable is not capable of an accent. Every word in an hexameter line that has a long syllable may be accented, unless the sense interpose, which rejects the accenting a word that makes no figure by its signification. But, notwithstanding this circumstance, there is constantly one accent in every line which makes a greater figure than any of the rest. Thus,

*Smooth flow the waves, the zephyrs gently play,  
Belinda smil'd, and all the world was gay.*

In order to facilitate the reading of dead languages, grammarians have adopted various characters for distinguishing the accents belonging to particular syllables; such as the acute, marked thus (´), the grave thus (`), and the circumflex thus (˘), or (ˆ), &c. The acute denotes that the voice is to be raised; the grave, that it is to be lowered or flattened; and the circumflex, that the syllable is to be lengthened or dwelt upon.

- ACCENT**, in music, is a certain modulation of sounds to express a passion, whether by the voice or instruments. See **MUSIC**.
- ACCENTER**, in music, one of the three fingers in a trio, *viz.* the person who sings the highest part. See **TRIO**.
- ACCEPTANCE**, in Scots law, denotes either a person's adhibiting his subscription to a bill or draught, by which he subjects himself to the payment of it; or accepting or agreeing to offers made in bargaining, by which the bargain is concluded.
- ACCEPTANCE**, in the church of Rome, is put for receiving the Pope's constitutions.
- ACCEPTANCE**, in commerce, is the subscribing, signing, and making one's self debtor for the sum contained in a bill of exchange, or other obligation. See **BILLS**.
- ACCEPTATION**, in grammar, the sense or meaning wherein any word is taken.
- ACCEPTER**, or **ACCEPTOR**, the person who accepts a bill of exchange, &c.
- ACCEPTION**, the same with acceptance.
- ACCEPTILATION**, among civilians, an acquittance or discharge given by the creditor to the debtor without the payment of any value.
- ACCESS**, the approach of one person or thing to another. It is also used by physicians for the beginning of a paroxysm.
- ACCESSARY**, or **ACCESSORY**, in law. See **ACCESSORY**.
- ACCESSIBLE**, something that may be approached, or that access may be had to. Thus we say, Such a place is accessible on one side, &c.
- ACCESSION**, in Scots law, is a method of acquiring property, by which, in things that have a close connexion or dependence upon one another, the property of the principal thing draws after it the property of the accessory. Thus, the owner of a cow becomes likewise the owner of the calf. See **LAW**, title, *Division of rights*. It sometimes likewise signifies consent or acquiescence.
- ACCESSION**, among physicians, is used for a paroxysm of a disease; among politicians, it signifies a prince's succeeding to the government upon the death of his predecessor.
- ACCESSORY**, in Scots law, is the subject acquired by accession; or, in crimes, it signifies the person by whose assistance, advice, or command, the crime was committed: In this latter sense, it is the same with accomplice, art and part, &c. See **LAW**, title, *Crimes*.
- ACCESSORY nerve**. See **ANATOMY**, Part V.
- ACCIB**, a name given by some authors to lead.
- ACCIDENT**, in a general sense, denotes any casual event.
- ACCIDENT**, in logic, signifies secondary qualities, or such as do not essentially belong to any subject.
- ACCIDENT**, in grammar. See **GRAMMAR**.
- ACCIDENT**, in heraldry, an additional point or mark in a coat of arms, which may be either omitted or retained without altering the essence of the armour; such as, *abatements, differences, and mixtures*.
- ACCIDENT**, among physicians, an obsolete term for a symptom.
- ACCIDENTS**, in astrology, the most remarkable occurrences in a man's life.
- Absolute ACCIDENT*, in the Romish church, an accident which may possibly subsist, at least miraculously, without a subject; which is unintelligible jargon.
- ACCIDENTAL**, something that happens by accident, or a mode that is not essential to its subject.
- ACCIDENTAL point**, in perspective. See **PERSPECTIVE**.
- ACCIDENTAL dignities and debilities**, in astrology, certain casual dispositions of the planets, whereby they are supposed to be either strengthened or weakened.
- ACCIPENSER**, in ichthyology, a genus of fishes belonging to the Amphibia Nantes of Linnæus. The accipenser has a single linear nostril: the mouth is in the under part of the head, and contains no teeth; the cirri are below the snout, and before the mouth. There are four species of this genus, *viz.* 1. The sturio, or sturgeon, with 4 cirri, and 11 squamous protuberances on the back. It inhabits the European seas. This fish was so greatly esteemed in the time of Severus, that he ordered it to be carried to his feasts by servants crowned with garlands, and trumpets playing before. See Plate I. fig. 5. 2. The ruthenus has 4 cirri, and 15 squamous protuberances. It is a native of Russia. 3. The huso has 4 cirri; the body is naked, *i. e.* has no prickles or protuberances. The skin of the huso is so tough and strong, that it is employed for ropes in carts and other wheel-carriages. Singlax is also made of the skin of this fish, and its eggs are sometimes made into pickles. It inhabits the Danube, and the rivers of Russia. See Plate I. fig. 6. 4. The plecostomus, which is distinguished from the other three by having only 2 cirri. It is a native of Surinam. The whole four species are viviparous.
- ACCIPENSIUS**. See **ACCIPENSER**.
- ACCIPITER**, the name of Linnæus's first order of birds. The birds belonging to this order have crooked beaks. This order comprehends only four genera, *viz.* The vultur, falco, strix, and lanus. See **VULTUR**, &c.
- ACCIPITRINA**, an obsolete name of the hierachium or hawkweed. See **HERACHIUM**.
- ACCISMUS**, in antiquity, signifies a feigned refusal of what one earnestly desires.
- ACCISMUS**, in rhetoric, is accounted a species of irony. See **IRONY**.
- ACCLAMATION**, any expression of joy, or applause, whereby the public testifies its approbation.
- ACCLAMATION** is also used, in a bad sense, for expressions of detestation.
- ACCLAMATION**, in rhetoric, a figure, the same with **EPHRONEMA**, which see.
- ACCLAMATION medals**, among antiquaries, such as represent the people expressing their joy in the posture of acclamation.
- ACCLIVUS**, in anatomy, a synonyme of the oblique ascendens muscle. See **ANATOMY**, Part II.
- ACCLIVITY**, the rise or ascent of a hill, in opposition to the declivity or descent of it. Some writers

Plate I.

Fig. 1. Abacus

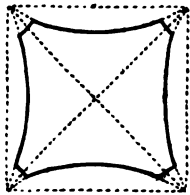


Fig. 2. Abacus or Counting Board

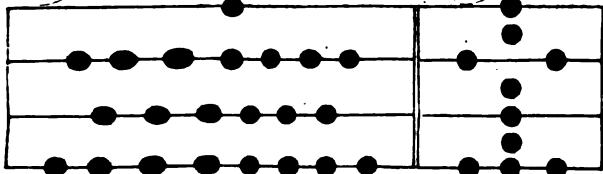


Fig. 4. Acarus

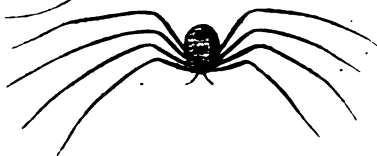


Fig. 5. Accipenser sturio or Sturgeon



Fig. 6. Accipenser huso or Jinglap Fish



Fig. 3. Acanthus



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*use in fortification use it for the value of a rampart.*  
**ACCLOYED**, in farriery, signifies pricked. Thus a horse's foot pricked in shoeing, is said to be *accloyed*.  
**ACCOLA**, among the Romans, signified that a person lived near some place.  
**ACCOLADE**, in antiquity, one of the forms of conferring knighthood, in which the prince laid his arms about the neck of the young knight, embraced him, and, some say, gave him a blow on the cheek, neck, or shoulder, in imitation of the form of manumission among the Romans.  
**ACCOLEE**, sometimes synonymous with **ACCOLADE**, which see. — It is also used in divers senses in heraldry: Sometimes it is applied to two things joined; at other times, to animals with crowns, or collars about their necks, as the lion in the Ogilvy's arms; and lastly to kews, batrons, maces, *&c.* placed saltier-wise behind the shield.  
**ACCOMMODATION**, making two or more things agree with one another. — Among divines, it is applying what is originally said of one person, or thing, to another: Thus the words of Isaiah to the Jews of his time, are, by our Saviour, accommodated to his contemporaries, and by St Paul to his. — In law, it signifies the amicable issue of a debate, which is effected sometimes by mediation of friends, sometimes by submission, and sometimes by a division of the subject in debate.  
**ACCOMPAGNAGE**, a term in the silk manufactures, signifying a fine woof of the same colour with the gilding, helping to enrich the ground under which it passes, and to hinder it from striking cross the gilding itself, which would diminish its gloss and lustre. All rich stuffs, the warps whereof are of a colour different from the gilding, should be accompanied.  
**ACCOMPANIMENT**, something attending or added as a circumstance to another, either by way of ornament, or for the sake of symmetry. See **CIRCUMSTANCE**.  
**ACCOMPANIMENT**, in music, these parts that are added to render the harmony more full and complete, as an instrument accompanying a voice. Among the moderns, the accompaniment frequently plays a different melody from the song it accompanies; but authors are not agreed whether it was so among the ancients. See **MUSIC**.  
**ACCOMPANIMENT**, in painting, denotes such objects as are added, either by way of ornament, or probability, as dogs, guns, game, *&c.* in a hunting piece. See **PAINTING**.  
**ACCOMPANIMENT**, in heraldry, any thing added to a shield by way of ornament; as the belt, mantling, supporters, *&c.* It is also applied to several bearings about a principal one; as a saltier, bend, fess, chevron, *&c.*  
**ACCOMPLICE**, in law. See **ACCESSORY**.  
**ACCOMPLISHMENT**, the entire execution or fulfilling of any thing.  
**ACCOMPLISHMENT**, is also used for any mental or personal endowment.  
**ACCOMPT**. See **ACCOUNT**.

**ACCOMPTANT**. See **ACCOUNTANT**.  
**ACCORD**, in music. See **CONCORD**.  
**ACCORD**, in law, an accommodation between parties at variance, by means of an offer made by the one, and accepted by the other.  
**ACCORD**, in painting, is the harmony that reigns among the lights and shades of a picture.  
**ACCORNEED**, in heraldry: When any figure of an animal, in an escutcheon, has horns of a different colour from those of the real animal, then it is said to be *accorneed*.  
**ACCOUNT**, or **ACCOMPT**, in a general sense, a computation or reckoning of any thing by numbers. Collectively, it is used to express the books which merchants, traders, bankers, *&c.* use for recording their transactions in business. See **BOOK-KEEPING**.  
**ACCOUNT in company**, is an account betwixt partners relating to the transactions of their joint concern. See **BOOK-KEEPING**.  
**ACCOUNT of sales**, is an account given by one merchant to another, or by a factor to his principal, of the disposal, charges, commission, and nett proceeds of certain merchandises sent for the proper or company account of him that consigned them to such factor or vender. See **BOOK-KEEPING**.  
**ACCOUNT current,—of goods**. See **BOOK-KEEPING**.  
**ACCOUNT in bank**, a fund which it is common for merchants or others to furnish themselves with in the cash of a bank, to be in readiness for the payment of bills of exchange, purchases, *&c.*  
**Auditing an ACCOUNT**, is the examining and passing an account by an officer appointed for the purpose. See **AUDITOR**.  
**Chamber of ACCOUNTS**, in the French polity, is a sovereign court of great antiquity, which takes cognizance of, and registers the accounts of the king's revenue. It is nearly the same with the English *Court of EXCHEQUER*; which see.  
**ACCOUNT in the remembrancer's office**, in the exchequer, is the state of any branch of the king's revenue; as the account of the mint, of the wardrobe, of the army, navy, *&c.*  
**ACCOUNT**, in law, the action that lies against a person who is accountable by office to another, but refuses to render the account.  
**ACCOUNT**, is also taken sometimes, in a particular sense, for the computation of time; as we say, The Julian account, the Gregorian account, *&c.* in which sense it is equivalent to *style*.  
**ACCOUNT** is also used in sundry mercantile forms of expression for advantage, hazard, loss, *&c.*  
**ACCOUNTABLE**, a term used to denote a person's being liable to render an account for any thing.  
**ACCOUNTANT**, or **ACCOMPTANT**, in the most general sense, is a person skilled in accounts. In a more restricted sense, it is applied to a person, or officer, appointed to keep the accounts of a public company, or office, as the South-sea, the India company, the bank, the excise, *&c.*  
**ACCOUNTANTSHIP**, the art of keeping and balancing accounts. See **BOOK-KEEPING**.

ACCOUNT-

**ACCOUNTANT-GENERAL**, a new officer in the court of Chancery appointed by act of parliament to receive all moneys lodged in court instead of the masters, and convey the same to the bank of England for security.

**ACCOUNTING-HOUSE**, counting-house, or compting-house, is a house, or office, set apart by a merchant, or trading-company, for transacting their business, as well as keeping their books, accounts, vouchers, &c.

**ACCOUTREMENT**, an old term, applied to the furniture of a soldier, knight, or gentleman.

**ACCRETION**, in physics, the increase, or growth, of an organical body, by the accession of new parts.

**ACCRETION**, among civilians, the property acquired in a vague or unoccupied thing, by its adhering to or following another already occupied; thus, if a legacy be left to two persons, one of whom dies before the testator, the legacy devolves to the survivor by right of accretion.

**ACCROCHE**, in heraldry, denotes a thing's being hooked with another.

**ACCROCHING**, in old law-books, is inroaching upon, or usurping another man's right.

**ACCRUE**, in law, any thing that is connected to another as an appendage.

**ACCUBATION**, in antiquity, the posture used by the Greeks and Romans at table. The body was extended, and the head resting on a pillow, or on the elbow.

The Romans at their meals made use of a low round table, around which two or three couches were placed in proportion to the number of guests; and hence it was called *biclinium*, or *triclinium*. These were covered with a sort of bed-cloaths, and furnished with quilts and pillows for leaning on. The guests reclined on the left side, the first at the head of the bed, with his feet behind the back of the second, &c. Before they came to table, they changed their cloaths, for what they called the *cenatoria vestes*, the dining garment, and pulled off their shoes to keep the couch clean.

**ACCUBITOR**, an ancient officer of the emperors of Constantinople, whose business was to lie near the emperor. He was the head of the youths of the bed-chamber, and had the *cubicularius* and *procubitor* under him.

**ACCUMULATION**, in a general sense, the act of heaping or amassing things together. Among lawyers it is used in speaking of the concurrence of several titles to the same thing, or of several circumstances to the same proof.

**ACCUMULATION of degrees**, in an university, is the taking several of them together, or at smaller intervals than usual, or than is allowed by the rules of the university.

**ACCURATE**. See **EXACTNESS**.

**ACCURSED**, denotes something that lies under a curse, or is detestable. It is likewise used for an excommunicated person.

**ACCUSATION**, in law, the charging any person with a criminal action, either in one's own name, or that

of the public. It differs little from impeachment or indictment.

**ACCUSATIVE**. See **GRAMMAR**.

**AC-DENGHIS**, a name given to the Archipelago by the Turks.

**ACE**, a term among gamblers, signifying a card or die marked with a single point.

**ACENTETUM**, or **ACENTETA**, names used by the ancients for the purest rock crystal. See **CRYSTAL**.

**ACEPHALI**, or **ACEPHALITÆ**, a name given, in ecclesiastical history, to several sects that were destitute of any head or leader; as also, to such bishops as were exempted from the jurisdiction of a patriarch.

**ACEPHALOUS**, in our ancient law-books, an appellation given to such persons as held nothing of any superior.

**ACEPHALUS**, without a head.

**ACEPHALUS**, an obsolete term for the tenia, or tapeworm. See **TENIA**.

**ACEPHALUS**, is also used to express a verse defective in the beginning.

**ACER**, in botany, the maple or sycamore tree, a genus of the polygamia diœcia class. There are ten species of this genus. The calix of the female is quinquefid, the corolla pentapetalous, the stamina eight, one pistil, and two seed-capsules. The calix of the male is also quinquefid, the corolla pentapetalous, and the stamina eight. There are only two species of the acer which are reckoned natives of England, *viz.* the pseudo-platanus, and the campestre.

**ACERB**, a sour rough astringency of taste, such as that of unripe fruit. See **ASTRINGENT**.

**ACERENZA**. See **CIRENZA**.

**ACERIDES**, signifies a plaster without any wax in its composition.

**ACERINA**, an obsolete name of a species of the perch, a fish of the thoracic order. See **PERCA**.

**ACERNO**, a town of Italy, in the kingdom of Naples, with a bishop's see. It is 17 miles S. W. of Conza, and 12 N. E. of Salerno, long. 14. 23. lat. 40. 55.

**ACERRA**, in antiquity, an altar erected, among the Romans, near the gate of a person deceased, on which his friends daily offered incense, till his burial.—The Chinese have still a custom like this; they erect an altar to the deceased in a room hung with mourning, and place an image of the dead person on the altar, to which every one that approaches it bows four times, and offers oblations and perfumes.

**ACERRA**, in geography, a town of Italy in the kingdom of Naples, and in the terra di Lavoro. It stands on the river Agno, 7 miles N. E. of Naples, and 20 S. W. of Benevento, lon. 14. 23. lat. 40. 55.

**ACERRÆ**, the pots wherein incense was burnt.

**ACERSECOMES**, long-haired, a name of Apollo, because he was usually painted so.

**ACESTIDES**, in foundery, a name given by the ancients to the chimneys of their furnaces wherein brass was made.

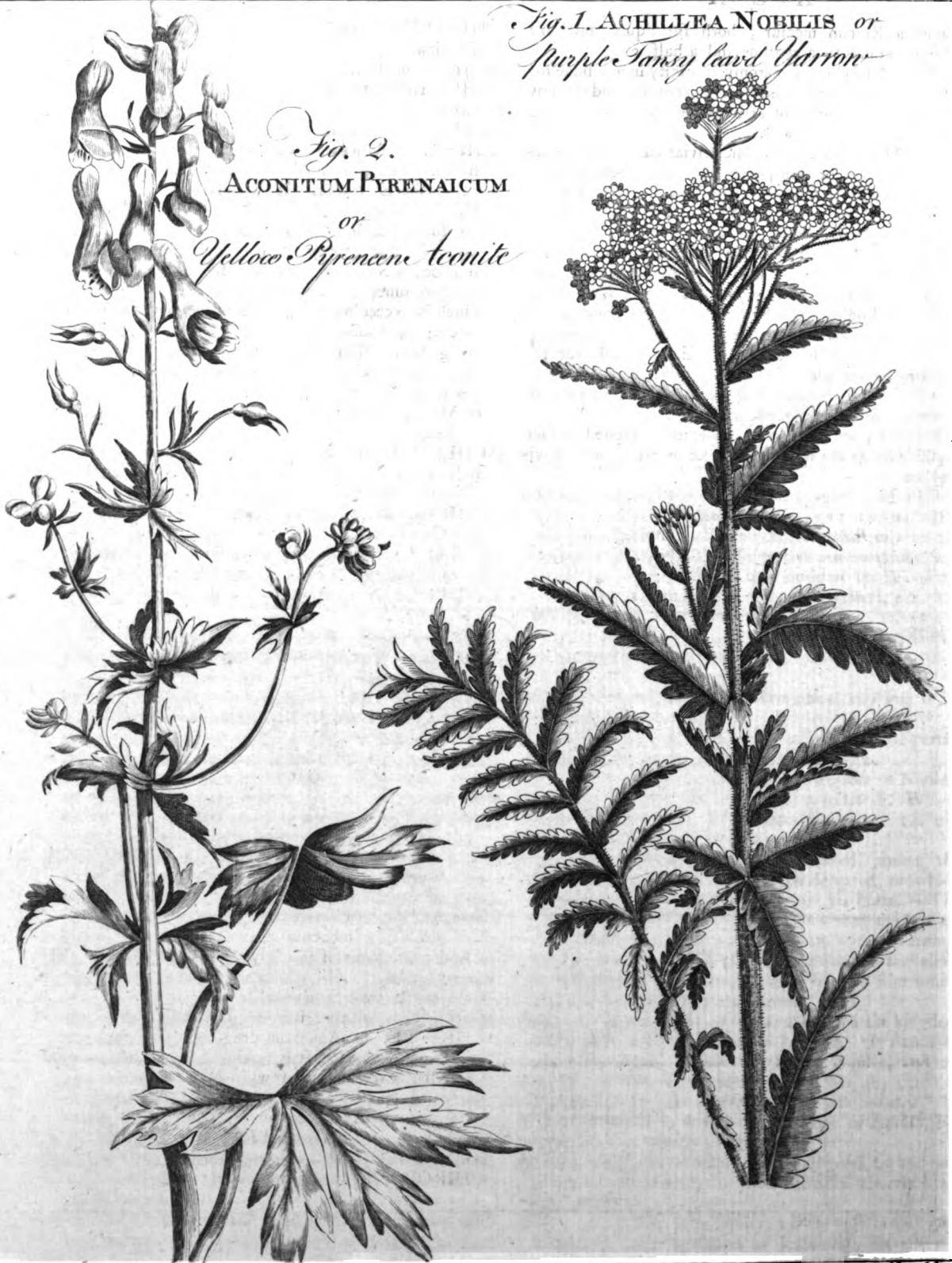
**ACETABULUM**, in antiquity, a little vase or cup used at table to serve up sauces or seasoning. It also de-

notes



Fig. 1. *ACHILLEA NOBILIS* or  
*Purple Fanny leaved Yarrow*

Fig. 2.  
*ACONITUM PYRENAICUM*  
or  
*Yellow Pyrenean Aconite*



- notes a Roman measure, both for liquid and dry things, equal to a cyathus and a half.
- ACETABULUM**, in anatomy, a cavity in any bone for receiving the protuberant head of another, and thereby forming that species of articulation called *enarthrosis*. See **ANATOMY**, Part I.
- ACETABULUM**, in botany, the trivial name of a species of the peziza, or cup-peziza, a fungus belonging to the cryptogamia fungi of Linnæus. It has got the name of *acetabulum* from the resemblance its leaves bear to a cup. See **PEZIZA**.
- ACETARY**. Nehemiah Grew, in his anatomy of plants, applies this term to a pulpy substance in certain fruits, e. g. the pear, which is inclosed in a congeries of small calculous bodies towards the base of the fruit, and is always of an acid taste. See **AGRICULTURE**, Sect. 1.
- ACETIFICATION**, a term used by chemists for the making of vinegar.
- ACETOSA**, in botany, a synonyme of the rumex, or sorrel. See **RUMEX**.
- ACETOSE**, or **ACETOUS**, an epithet applied to such substances as are sour, or partake of the nature of vinegar.
- ACETUM**, vinegar, the vegetable acid of the chemists. See **CHEMISTRY**, title, *Of acids*.
- ACETUM distillatum**, in chemistry, distilled vinegar.
- ACETUM esuriens**, in chemistry, a distilled vinegar, rectified by the help of verdigrease.
- ACETUM radicum**. Boerhaave thinks the *tartarus regeneratus* is the *acetum radicum* of the old chemists.
- ACGHIAH-SARAI**, a town on the north shore of the Caspian sea.
- ACHE**, or **ACHE**, in medicine, a term used for any severe pain, as head-ach, tooth-ach, &c. See **MEDICINE**.
- ACHAC**, a barbarous name of a species of the tetrao, a bird of the order of gallinæ. See **TETRAO**.
- ACHÆINUS**. See **ACHÆNUS**.
- ACHAIA**, a province of Turkey in Europe, now called *Livadia*, of which Athens was anciently the capital, at present named *Saithines* or *Setines*. See **LIVADIA**.
- ACHALACTLI**, in ornithology, a barbarous name of the columba cyanocephala. See **COLUMBA**.
- ACHAM**, a country in the E. Indies, bounded on the N. by Bouton, on the E. by China, on the S. by Ava, and on the W. by Patan and Jesuat in Bengal. It is very little known to the Europeans.
- ACHANE**, in Persian antiquity, a corn-measure, equal to forty-five Attic medimni. See **MEDIMNI**.
- ACHANDES**. See **REMORA**.
- ACHAOVA**, in botany, an obsolete name of the *marum matricaria*, &c. See **MARUM**.
- ACHASSES**, a river of Languedoc in France.
- ACHAT**, in the law-French, signifies a contract or bargain, especially by way of purchase.
- ACHAT**. See **AGAT**.
- ACHATOR**, in the old law-books, is used for **PURVEYOR**, which see.
- ACHBALUC-MANGI**, a town in the northern confines of China.
- ACHE**, in medicine. See **ACH**.
- ACHECAMBEY**, one of the Bahama islands. See **BAHAMA**.
- ACHELO**, a town near the Euxine sea.
- AGHEN**, or **ACHEM**, a capital town of a kingdom of the same name, in the N. part of the island of Sumatra, in the E. Indies. It extends as far as the line. The inhabitants are generally very superstitious. It has for a considerable time been a noted place for trade; and was formerly governed by a queen; but in 1700, a Saïd, or Preacher, found means to usurp the government. Its principal produce is gold dust, which is exceeding good. They punish theft very severely; yet robbery and murder are very frequent among them. This town is seated by the side of a river, and the king's palace is in the middle of the town, and is well fortified. It is 450 miles N. W. of Malua, and 1000 S. E. of Fort St George, 95.55. E. long. 5. 30. lat.
- ACHERNER**, in astronomy, a star of the first magnitude in the southern extremity of the constellation Eridanus. See **ERIDANUS**, and **ASTRONOMY**.
- ACHETA**, an obsolete name of the gryllus or cricket. See **GRYLLUS**.
- ACHIAR**, a Malayan word, signifying a sort of fruit or roots pickled with vinegar and spice. See **BAMBOE**.
- ACHIENUS**, a name given by the ancients to the cervus or stag. See **CERVUS**.
- ACHILLÆA**, in botany, a genus of plants belonging to the syngenesia polygamia superflua class. Of this genus there are 21 species, only two of which are natives of Britain, viz. the achillæa millefolium, or common yarrow, (see Plate II. fig. 1.) and the achillæa ptarmica, or sneezewort.
- ACHILLÆA**, a name frequently given by the ancients to the gum called dragons blood. See **DRAGONS-BLOOD**.
- ACHILLEID**, **ACHILLEIS**, a celebrated poem of Statius, in which that author proposed to deliver the whole life and exploits of Achilles; but being prevented by death, he has only treated of the infancy and education of his hero.
- Tendo* **ACHILLIS**. See **ANATOMY**, Part II.
- ACHIMENES**, in botany, a synonyme of the columnnea scandens, a genus of the didynamia angiospermia class. See **COLUMNNEA**.
- ACHIOTE**. See **ACHIOTTE**.
- ACHIOTL**, a name given to the drug *achiotte*.
- ACHIOTTE**, an American drug, used in dying and in making chocolate. It is produced from the mitella diphylla, a tree which grows in North America. Between the small filaments or leaves of this tree, little grains of a vermilion colour are found, which the Indians make into cakes, and send in this form to Europe; it is supposed to promote urine.
- ACHIROPOETOS**, a name given, by ancient writers, to certain pictures of Christ and the Virgin supposed to have been miraculously made without hands.

- ACHLAR**, a river in America, called *Araxis* by the ancients.
- ACHLIS**. See **MACHLIS**.
- ACHLYS**, in medicine, a dimness of sight, arising from any scar remaining after an ulcer in the cornea. It is also used for the disorder called a *suffusion of the uterus*.
- ACHMETSCHET**, a town of the peninsula of the Crimea, the residence of the sultan Galga, who is eldest son of the Khan of Tartary, 51. 20. long. 45. 0. lat.
- ACHONRY**, a small town of Ireland in the province of Connaught, and county of Sligo, seated on the river Shannon.
- ACHOR**, in medicine, small ulcers on the face which discharge a viscid humour. See **MEDICINE**.
- ACHRAS**, in botany, a genus of the hexandria monogynia class. It bears a fruit not unlike the pear. There are only three species of the achras, *viz.* the mimosa, the sapota, and the salicifolia, all natives of America.
- ACHRONICAL**, **ACHRONYCAL**, or **ACRONYCHAL**. See **ACRONICAL**.
- ACHYR**, a strong town and castle of the Ukraïn, subject to the Russians since 1667. It stands on the river Uorsklo near the frontiers of Russia, 127 miles W. of Kiow, 36. 0. long. 49. 32. lat.
- ACHYRANTES**, in botany, a genus of the pentandria monogynia class. There are seven species of the achyrantes, most of them natives of the Indies.
- ACHYRANTHA**, in botany, the trivial name of a species of the illecebrum. See **ILLECEBRUM**.
- ACHYRONIA**, in botany, an obsolete name of a genus of the diadelphia decandria class.
- ACHYROPHORUS**, in botany, a synonyme of the feriola. See **SERIOLA**.
- ACIA**, a term in the Roman surgery, about the meaning of which physicians and commentators are greatly divided; some taking it for the needle, and others for the thread.
- ACICULÆ**, the small spikes or prickles of the hedgehog, echinus marinus, &c.
- ACIDS**, substances which give a sour, sharp, or tart taste. Among the chemists, the acid salts are distinguished into the nitrous, vitriolic, muriatic, and vegetable. See **CHEMISTRY**, title, *Of acids*.
- ACIDS**, in the materia medica, are such medicines as possess an acid quality; such as vinegar, spirit of vitriol, &c. These being powerful antiseptics, are esteemed good in all putrid and malignant diseases, and, by their cooling virtue, are no less efficacious in feverish and inflammatory cases.
- ACIDITY**, that quality which renders bodies acid.
- ACIDOTON**, in botany, is both a synonyme and the trivial name of a species of the adelia. See **ADELIA**.
- ACIDULÆ**, a term for water or any substance impregnated with an acid.
- ACIDULATED**, a name given to medicines that have an acid in their composition.
- ACIERNO**, a town in the Hither Principality, in the kingdom of Naples, with a bishop's see. It is 15 miles E. of Salerno, 37. 0. E. long. 40. 52. lat.
- ACINAIES**, in antiquity, a kind of cutlafs, or scimeter, in use among the Persians.
- ACINARIA**, in botany, a synonyme of the fucus acinarius, belonging to the cryptogamia algæ of Linnæus. See **FUCUS**.
- ACINI**, in botany, a synonyme of the thymus alpinus. See **THYMUS**.
- ACINIFORMIS tunica**, in anatomy. See **UVULA**.
- ACINODENDRION**, in botany, the trivial name of a species of the melastoma. See **MELASTOMA**.
- ACINODENDRUM**, in botany, a synonyme of two species of the melastoma.
- ACINOIDES**, in botany, the trivial name of a species of the ziziphora. See **ZIZIPHORA**.
- ACINOS**, in botany, a synonyme of a species of the cunila. See **CUNILA**.
- ACINUS**, in botany, signifies grapes or berries growing in clusters.
- ACISONTHERA**, in botany, both a synonyme and the trivial name of a species of the rhexia. See **RHEXIA**.
- ACITLI**, in ornithology, the American name of the colymbus cristatus, a bird of the order of anseres. See **COLYMBUS**.
- ACKNOWLEDGMENT**, in a general sense, is a person's owning or confessing a thing; but, more particularly, is the expression of gratitude for a favour.
- ACKNOWLEDGMENT-money**, a certain sum paid by tenants in several parts of England, on the death of their landlords, as an acknowledgment of their new lords.
- ACLIDES**, in Roman antiquity, a kind of missile weapon, with a thong affixed to it, whereby to draw it back. Most authors describe it as a sort of dart or javelin; but Scaliger makes it roundish or globular, with a slender wooden stem to poise it by.
- ACLOWA**, in botany, a barbarous name of a species of colutea. It is used by the natives of Guinea to cure the itch. See **COLUTEA**.
- ACME**, or **ACKME**, the top or height of any thing. It is usually applied to the maturity of an animal just before it begins to decline; and physicians have used it to express the utmost violence or crisis of a disease.
- ACMELLA**, in botany, the trivial name of a species of the verbesina. See **VERBESINA**.
- ACNIDA**, in botany, a genus of the dicecia pentandria class. There is only one species of it, *viz.* the acnida canabina. It is a native of Virginia.
- ACNUA**, in Roman antiquity, signified a certain measure of land, near about the English rood, or fourth part of an acre. See **ROOD**.
- ACOBA**, a small town of Portugal in the province of Estremadura.
- ACOEMETÆ**, or **ACOEMETI**, in church history, or men who lived without sleep; a set of monks who chaunted the divine service night and day in their places of worship. They divided themselves into three bodies, who alternately succeeded one another, so that their churches were never silent. This practice they founded upon the precept, *Pray without ceasing*. They flourished in the east about the middle of the fifth century. There are a kind of acœmeti still subsisting in the

- Roman Church**, *viz.* the religious of the holy sacrament, who keep up a perpetual adoration, some one or other of them praying before the holy sacrament, day and night.
- ACOLASTRE**, a small river of France in the Nivernois.
- ACOLCHICHI**, in ornithology, a barbarous name of the phœnicopterus, a bird of the order of gallæ. See **PHœNICOPTERUS**.
- ACOLIN**, an obsolete name of a species of the tetrao, of the order of gallinæ. See **TETRAO**.
- ACOLIN**, in geography, a river of France which takes its rise in the Bourbonnois.
- ACOLUTHI**, a term applied to persons who were firm and steady in their opinions, and particularly to the stoics, who were remarkably tenacious of their resolutions and principles.  
In church-history, the term *acolythus*, or *acolythist*, is peculiarly applied to candidates for the ministry who continually attend the bishops.
- ACOLYTHIA**, in the Greek church, denotes the office or order of divine service; or the prayers, ceremonies, hymns, &c. whereof the Greek service is composed.
- ACOMA**, a town of N. America, in New-Mexico, seated on a high mountain, with a strong castle. It is the capital of the province, and was taken by the Spaniards in 1599, 108. 35. W. long. 35. 0. lat.
- ACOMAC**, a county of Virginia, in N. America, being a peninsula, bounded on the N. by Maryland; on the E. and S. by the ocean, and on the W. by the bay of Chese-peak. Cape Charles is at the entrance of the bay, being the most southern promontory of this county.
- ACONE**, a species of whet-stone. See **COS**.
- ACONITUM**, in botany, a genus of the polyandria trigynia. There are seven species of the aconitum. 1. The lycostomum, is a native of Lapland, Switzerland, and other hilly countries of Europe. 2. The unicornatum, is a native of Philadelphia. 3. The variegatum grows on the Italian and Bohemian mountains. 4. The napellus, is a native of Switzerland, Bavaria, and France. 5. The Pyrenaicum, is a native of Siberia, Tartary, and the Pyrenean mountains. See plate II. fig. 2. 6. The cammarum, and, 7. The anthora, are both natives of Taurus and the Pyrenean mountains. The English name of the aconitum is *wolfbane* or *monksblood*. Each species is highly acrid, and extremely dangerous when taken into the stomach, as it generally occasions convulsions, and frequently a mortification in that organ.
- ACONTIAS**, in zoology, an obsolete name of the anguis jaculus, or dart-snake, belonging to the order of amphibia serpentes. See **ANGUIS**.
- ACONTIAS**, is also a name applied by some writers to a kind of comet or meteor, whose head appears roundish or oblong, and its tail long and slender, like a dart or arrow.
- ACONTIUM**, in ancient writers, a kind of Grecian dart or javelin, somewhat resembling the Roman pilum.
- ACOPA**, in botany, an obsolete name of a species of the trifolium, See **TRIFOLIUM**.
- ACOPA**, also signifies medicines for refreshing the body after great fatigue.
- ACOPAM**. See **ACOPA**.
- ACOPIS**, a kind of fossil, mentioned by Pliny.
- ACOPUM**, among ancient physicians, a topical medicine composed of warm and emollient ingredients for allaying the sense of weariness.
- ACORES**, in geography. See **AZORES**.
- ACORN**, the fruit of the oak-tree. See **QUERCUS**.
- ACORUM**, in botany, a synonyme of the acorus. See **ACORUS**.
- ACORUS**, in botany, the sweet-smelling flag or calamus, a genus of the hexandria monogynia class. It is a native of this as well as other European countries. There are three varieties of this genus, *viz.* the acorus calamus; the vulgaris, or aromaticus of the shops; and the verus, which chiefly grows in the Indies.
- ACORUS**, in mat. med. a name sometimes given to the great galangal. See **GALANGAL**.
- ACORUS**, in botany, is likewise a synonyme of the iræ pseudacorus. See **IRIS**.
- ACOUSMATICI**, sometimes also called *Acoustici*, in Grecian antiquity, such disciples of Pythagoras as had not completed their five years probation. See **PYTHAGOREAN philosophy**.
- ACOUSTIC**, in general, denotes any thing that relates to the ear, or the sense of hearing.
- ACOUSTIC duct**, in anatomy, the same with meatus auditorius, or the external passage of the ear. See **ANATOMY**, Part VI.
- ACOUSTIC instrument**, an instrument made in the form of a horn, perforated at the small end, to assist hearing.
- ACOUSTIC nerve**, the same with the auditory nerve. See **ANATOMY**, Part V. and *Auditory nerve*.
- ACOUSTICS**, with physicians, medicines for curing deafness.
- ACQS**, a town at the foot of the Pyrenean mountains in the government of Foix in France. It takes its name from the hot waters in these parts; 1. 25. E. long. 43. 0. lat.
- ACQUA**, a town in the Grand Duchy of Tuscany, where there are warm baths, 12. 5. E. long. 43. 45. lat.
- ACQUA-CHE-TAVELLA**, a celebrated fountain of Italy, in Calabria-citerior, a province of Naples. It is near the mouth of the river Crata, and the ruins commonly called *Sibari rovinata*. It has been said to beautify those who washed in it.
- ACQUAPENDENTE**, a pretty large town of Italy, in the territory of the church, and patrimony of St Peter, with a bishop's see. It is seated on a mountain, near the river Paglia, 10 miles W. of Orvieto, and 57 N. by W. of Rome, 11. 53. E. long. 42. 43. lat.
- ACQUARIA**, a small town of Italy, in Frigiana, a district of Modena, which is remarkable for its medicinal waters. It is 12 miles south of the city of Modena, 11. 17. E. long. 44. 24. lat.
- ACQUAVIVA**, a small town in the Terra di Bari, a province in the kingdom of Naples, 17. 25. E. long. 41. 10. lat.

ACQUEST,

**ACQUEST**, or **ACQUIST**, in law, signifies goods got by purchase or donation. See **CONQUEST**.

**ACQUI**, a town of Italy, in the Dutchy of Montserrat, with a bishop's see, and commodious baths. It was taken by the Spaniards in 1745, and retaken by the Piedmontese in 1746; but after this, it was taken again and dismantled by the French, who afterwards forsook it. It is seated on the river Bormio, 25 miles N. W. of Genoa, and 30 S. of Casal, 8. 30. E. long. 44. 40. lat.

**ACQUIESCENCE**, in commerce, is the consent that a person gives to the determination given either by arbitration, or by a consul.

**ACQUIETANDIS plegiis**, in the English law, is a writ that lies for a surety, against a creditor, who refuses to acquit the complainant after the debt is paid.

**ACQUIETANTIA de sibiris et hundredis**, in England, signifies the privilege of being free from suit and service in shires and hundreds.

**ACQUISITION**, in general, denotes the obtaining or procuring something. Among lawyers, it is used for the right or title to an estate got by purchase or donation.

**ACQUITARE**, in ancient law-books, signifies to discharge or pay off the debts of a person deceased.

**ACQUITTAL**, a discharge, deliverance, or setting of a person free from the guilt or suspicion of an offence.

**ACQUITTANCE**, a release or discharge in writing for a sum of money.

**ACRA**, a town of Africa, on the coast of Guinea, where the English, Dutch, and Danes, have strong forts, and each fort its particular village, 0. 2. W. long. 5. 0. lat.

**ACRASIA**, among physicians, signifies the predominancy of one quality over another.

**ACRE**, or **Acra**, a sea-port town in Syria. It was formerly called *Ptolemais*, and is a bishop's see. It was very famous in the time of the crusadoes, and underwent several sieges both by the Christians and Saracens. It is now an inconsiderable town, being entirely supported by its harbour, which is frequented by ships of several nations. It is 20 miles S. of Tyre, and 37 N. of Jerusalem, 39. 25. E. long. 32. 40. lat.

**ACRE**, in the Mogul's dominions, the same with lack, and signifies the sum of 100,000 rupees; the rupee is of the value of the French crown of 3 livres, or 30 sols of Holland; an 100 lacks of rupees make a couron in Indostan, or 10,000,000 rupees; the pound Sterling is about 8 rupees; according to which proportion, a lack of rupees amounts to 12,500 pounds Sterling.

**ACRE**, a measure of land used in several provinces of France, particularly in Normandy. It is larger or less according to the different places; but commonly contains 160 perches.

*The ACRE of woods in France*, consists of four roods, called *verg'es*; the rood is 40 perches, the perch 24 feet, the foot 12 inches, the inch 12 lines.

**ACRE**, the universal measure of land in Britain. An acre in England contains 4 square roods, a rood 40

perches or poles of 16 $\frac{1}{2}$  feet each by statute. Yet this measure does not prevail in all parts of England, as the length of the pole varies in different counties, and is called *customary measure*, the difference running from the 16 $\frac{1}{2}$  feet to 28. The acre is also divided into 10 square chains, of 22 yards each, that is 4840 square yards. An acre in Scotland contains 4 square roods; 1 square rood is 40 square falls; 1 square fall, 36 square ells; 1 square ell, 9 square feet, and 73 square inches; 1 square foot, 144 square inches. The Scots acre is also divided into 10 square chains; the measuring chain should be 24 ells in length, divided into 100 links, each link 8 $\frac{1}{2}$  inches; and so 1 square chain will contain 10,000 square links.

The English statute acre is about 3 roods and 6 falls standard measure of Scotland.

**ACREME**, in old law-books, signifies ten acres of land.

**ACRIBELA**, signifies great accuracy.

**ACRID**, a name for any thing that is of a sharp or pungent taste.

**ACRIDOPHAGI**, signifies *locust-eaters*. It has been much disputed whether the inhabitants of Arabia, Ethiopia, &c. ever eat locusts. We shall give the substance of what Hasselquist says on this subject, who travelled in Syria and Egypt so late as the year 1752. This ingenious gentleman, who travelled with a view to improve natural history, informs us, that he asked Franks, and many other people who had lived long in these countries, whether they had ever heard that the inhabitants of Arabia and Ethiopia, &c. used locusts as food. They answered that they had. He likewise asked the same question of Armenians, Coptes, and Syrians, who lived in Arabia, and had travelled in Syria and near the Red-sea; some of whom said they heard of such a practice, and others that they had often seen the people eat these insects. He at last obtained complete satisfaction on this head from a learned sheek at Cairo, who had lived six years in Mecca. This gentleman told him, in presence of M. le Grand, the principal French interpreter at Cairo, and others, that a famine frequently rages at Mecca when there is a scarcity of corn in Egypt, which obliges the inhabitants to live upon coarser food than ordinary: That when corn is scarce, the Arabians grind the locusts in hand-mills, or stone mortars, and bake them into cakes, and use these cakes in place of bread: That he has frequently seen locusts used by the Arabians, even when there was no scarcity of corn; but then they boil them, stew them with butter, and make them into a kind of fricassée, which he says is not disagreeably tasted; for he had sometimes tasted these locust-fricassees out of curiosity. From this account, we may see the folly of that dispute among divines about the nature of St John's food in the wilderness. Some of them say that locusts were the fruits of certain trees, others that they were a kind of birds, &c.; but those who adhered to the literal meaning of the text were at least the most orthodox, although their arguments were perhaps not so strong as they might have been, had they had an opportunity of quoting such an author as Hasselquist.

**ACRI-**



- ACRIFOLIUM**, in botany, a sharp or prickly leaf.
- ACRIMONY**, that quality in bodies which renders them acrid to the taste.
- ACRIVIOLA**, in botany, a synonyme of a species of tropezolium or Indian cress. See **TROPEZOLUM**.
- ACROAMATIC**, or **ACPOATIC**, in general, denotes a thing sublime, profound, or abstruse. Aristotle's lectures to his favourite disciples and intimate friends bore this denomination, in opposition to his exoteric lectures, or those accommodated to a popular audience.
- ACROBATICA**, or **ACROBATICUM**, in Grecian antiquity, an engine whereby the people were raised aloft, that they might see further, or with greater advantage. It was much the same with the scanorium of the Latins.
- ACROCHIRISMUS**, in Grecian antiquity, a kind of gymnastic exercise, performed with the fists, without closing at all.
- ACROCHORDON**, a painful wart, which is very prominent and pendulous.
- ACROCORION**, in botany, an obsolete name of the crocus. See **CROCUS**.
- ACROMATIC**, or **ACHROMATIC**, in optics, a term applied to a particular kind of telescope, the most perfect of the refracting kind. See **OPTICS** and **TELESCOPE**.
- ACROMION**, in anatomy, the upper part of the scapula. See **ANATOMY**, Part I.
- ACROMONOGRAMMATICUM**, in poetry, a kind of poem, wherein every subsequent verse begins with the letter wherewith the immediately preceding one terminated.
- ACRON**, a territory on the gold coast of Guinea in Africa, bordering on the Fantynean country. The Dutch have a fort here, called *Fort Patience*. The inhabitants apply themselves principally to husbandry. They are a very ignorant people, and go naked like the rest of the negroes.
- ACRON**, among ancient botanists, signifies the top or flower of plants of the thistle kind.
- ACRONICAL**, **ACHRONICAL**, or **ACHRONICAL**, in astronomy, is a term applied to the rising of a star, when the sun is set in the evening; but has been promiscuously used to express a star's rising at sunset, or setting at sunrise.
- ACROSPIRE**, a vulgar term for what the botanists call the *plume*. See **AGRICULTURE**, *Of vegetation*.
- ACROSPIRED**, in malt-making, is the grain's shooting both at the root and blade end. See **MALT**.
- ACROSTIC**, **ACROSTICUM**, in poetry, a poem disposed in such a manner, that the initial letters of the verses make some person's name, title, motto, &c.
- ACROSTICUM**, in botany, a genus of the cryptogamia filices, of which there are 30 species, but only three of them are natives of Britain, viz the septentrionale, or horned fern; the ilvense, or hairy fern; and the thalypteris, or marsh fern.
- ACROSTOLIUM**, in ancient naval architecture, the extreme part of the ornament used on the prows of their ships, which was sometimes in the shape of a buckler, helmet, animal, &c.; but more frequently circular, or spiral. It was usual to tear them from the prows of vanquished vessels, and fix them to the conquerors, as a signal of victory.
- ACROTELEUTIC**, among ecclesiastic writers, an appellation given to any thing added to the end of a psalm, as the Gloria Patri or doxology.
- ACROTERI**, a town in the island of Santorin, that lies in the sea of Candia, 25. 26. E. long. 36. 25. lat.
- ACROTERIA**, in architecture, small pedestals, usually without bases, anciently placed at the middle and the two extremes of pediments or frontispieces, serving to support the statues, &c. It also signifies the figures placed as ornaments on the tops of churches, and the sharp pinnacles that stand in ranges about flat buildings with rails and ballusters.
- Among ancient physicians, it signified the larger extremities of the body, as the head, hands, and feet. It has also been used for the tips of the fingers, and sometimes for the eminences or processes of bones.
- ACRITHYMIA**, in surgery, a large tumour resembling a wart, though sometimes flat and depressed. See **SURGERY**, title, *Of tumours*.
- ACSOR**, a town in the river Nile in Egypt, famed for its earthen ware.
- ACSU**, a town in Asiatic Tartary, situated in 40. 30. N. lat.
- ACT**, in general, denotes the exertion of power; and differs from power, as the effect from the cause.
- ACT**, among lawyers, is an instrument in writing for declaring or justifying the truth of any thing. In which sense, records, decrees, sentences, reports, certificates, &c. are called *Acts*.
- ACTS**, also denote the deliberations and resolutions of an assembly, senate, or convocation, as, Acts of parliament, &c.
- Act of faith, auto da fe**, in the Romish church, is a sort of jail delivery, for the punishment of heretics, and the absolution of those who are found to be innocent. The culprits are first led to church, where their sentence, either of condemnation or absolution, is pronounced, and the guilty are delivered over to the secular power, with an earnest intercession for them, that no blood may be shed. But if they persist in their supposed errors, they are burnt alive. See **INQUISITION**.
- ACTS**, in dramatic poetry, are the parts or divisions into which tragedies and comedies are generally split. Dramatic compositions usually consist of five acts. But this division is not essentially necessary, but may be varied according to the humour of the author, or the nature of the subject. See **DRAMA**.
- Act of grace**. See **GRACE**.
- ACTÆA**, in botany, a genus of the polyandria monogynia class. There are three species of this plant, viz. the actæa spicata, or bone-berries, which is a native of Britain; the racemosa, which is a native of America; and the cimicifuga, which is a native of Siberia.
- ACTION games**, in Roman antiquity, were solemn games

- games instituted by Augustus, in memory of his victory over Marc Anthony at Actium, held every fifth year, and celebrated in honour of Apollo, since called *Actian*. Hence Actian years, an æra commencing from the battle of Actium, called the *Æra of Augustus*.
- ACTION**, in a general sense. See **ACT**.
- ACTION**, in mechanics, the motion produced by the impulse of one body upon another. See **MECHANICS**.
- ACTION**, in ethics, denotes the external signs or expressions of the sentiments of a moral agent. See **ETHICS**, **METAPHYSICS**.
- ACTION**, in poetry, the same with the subject or fable. Critics generally distinguish two kinds, the principal and the incidental. The principal action is what is generally called the *fable*; and the incidental an *episode*. See **DRAMA**.
- ACTION**, in oratory, is the outward deportment of the orator, or the accommodation of his countenance, voice, and gesture, to the subject of which he is treating. See **ELOQUENCE**.
- ACTION**, in a theatrical sense, is much the same with action in oratory; the one adapts his action to an assumed character, the other is supposed to feel in reality what he expresses.
- ACTION**, in painting and sculpture, is the posture of a statue or picture, serving to express some passion, &c.
- ACTION**, among physicians. See **MOTIONS**.
- ACTION**, in commerce, is a term used abroad for a part or share in a company's stock or capital.
- ACTION**, in Scots law, is a demand made before a judge for obtaining what we are legally intitled to demand, and is more commonly known by the name of law-suit or process. See **LAW**, title, *Actions*.
- ACTIONARY**, or **ACTIONIST**, a proprietor of stock in a trading company.
- ACTIONS**, among merchants, sometimes signify moveable effects; and we say the merchant's creditors have seized on all his actions, when we mean that they have taken possession of all his active debts.
- ACTIVE**, denotes something that communicates action or motion to another; in which acceptation it stands opposed to passive.
- ACTIVE**, in grammar, is applied to such words as express action; and is therefore opposed to passive. The active performs the action, as the passive receives it.
- ACTIVE principles**, in chemistry, such as are supposed to act without any assistance from others; as mercury, sulphur, &c. See **CHEMISTRY**.
- ACTIVITY**, in general, denotes the power of acting, or the active faculty. See **ACTIVE**.
- Sphere of ACTIVITY*, the whole space in which the virtue, power, or influence of any object is exerted.
- ACTIUS**, in mythology, a surname of Apollo, from Actium, where he was worshipped.
- ACTOR**, in general, signifies a person who acts or performs something.
- ACTOR**, in the drama, is a person who represents some part or character upon the theatre. The drama in its original only consisted of a simple chorus, who sung hymns in honour of Bacchus; so that the primitive actors were only singers and musicians. Theſpis was the first who introduced a *persona*, or actor, to ease the chorus, by reciting the adventures of some of their heroes. Æschylus introduced a second, and changed the ancient recitals into dialogues. Sophocles added a third, in order to represent the variety of incidents in a more natural manner. And here the Greeks stopped; at least we do not find, in any of their tragedies, above three persons in the same scene, though, in their comedies, they took a greater liberty. The ancient actors were masked, which must have been a great disadvantage to their action, as they were thereby deprived of all the variety of expression the countenance is capable of. Actors were as much honoured at Athens, as they were despised at Rome. The French have, in this particular, adopted the manner of the Romans, and the English that of the Athenians. See **DRAMA**.
- ACTORUM tabule**, in antiquity, were tables instituted by Servius Tullius, in which the births of children were registered. They were kept in the treasury of Saturnus.
- ACTRESS**, a woman who performs a part upon the stage. Women actors were unknown to the ancients.
- ACTUAL**, something that is real and effective, or that exists truly and absolutely.
- ACTUARIÆ naves**, a kind of ships among the Romans, chiefly designed for swift sailing.
- ACTUARIUS**, or **ACTARIUS**, a notary or officer appointed to write the acts or proceedings of a court, or the like. In the Eastern empire, the actuarii were properly officers who kept the military accounts, received the corn from the *susceptores*, or store-keepers, and delivered it to the soldiers.
- ACTUATE**, to bring into act, or to put a thing in motion, or to stir up a person to action.
- ACTUS**, in ancient architecture, a measure in length equal to 120 Roman feet. In ancient agriculture, the word signified the length of one furrow, or the distance a plough goes before it turns.
- Actus minimus**, was a quantity of land 120 feet in length, and four in breadth.
- Actus major**, or **Actus quadratus**, a piece of ground in the square form, whose side was equal to 120 feet, equal to half the jugerum.
- Actus intervencialis**, a space of ground four feet in breadth, left between the lands as a path or way.
- ACUANITES**, or **ACUANITÆ**, a branch of those ancient heretics who bore the general name of Manichees. This branch took their distinguishing title from Acua; a disciple of Thomas.
- ACUBENE**, in astronomy, the Arabic name of a star of the fourth magnitude, in the southern forceps of Cancer; by Bayer marked A. See **ASTRONOMY** and **CANCER**.
- ACUHYTLI**, a barbarous name of a species of serpent.
- ACUITION**. See **ACUTITION**.
- ACULEATE**, or **ACULEATI**, a term applied to any plant or animal armed with prickles.

ACU-

**ACULEATUS**, in ichthyology, a synonyme of the gasterosteus or stickle-back. See **GASTEROSTEUS**.

**ACULEI**, the prickles of animals or of plants.

**ACULEOSA**, in botany, a synonyme of the gorteria ciliaris and the roella ciliata. See **GORTERIA**, **ROSELLA**.

**ACULER**, in the menage, is used for the motion of a horse, when, in working upon volts, he does not go far enough forward at every time or motion, so that his shoulders embrace or take in too little ground, and his croupe comes too near the centre of the volt. Horses are naturally inclined to this fault in making demi-volts.

**ACUMEN**, in the ancient music, a sound produced by the intension or raising of the voice.

**ACUMINA**, in antiquity, a kind of military omen, most generally supposed to have been taken from the points or edges of darts, swords, or other weapons.

**ACUMULO**, a small town in Abruzzo Ulterior, a province of the kingdom of Naples, 17. 15. long. 39. 30. lat.

**ACUPUNCTURE**, the name of a surgical operation among the Chinese and Japanese, which is performed by pricking the part affected with a silver needle. They employ this operation in head-achs, lethargies, convulsions, colics, &c.

**ACUS**, in ichthyology, the trivial name of a species of syngnathus. See **SYNGNATHUS**.

**ACUTE**, as applied to angles, triangles, cones, &c. See these articles.

**ACUTE accent**, in grammar. See **ACCENT**.

**ACUTE**, in music, signifies a tone that is sharp, shrill, or high, in respect of some other, and is opposed to grave.

**ACUTE diseases**, such as come suddenly to a crisis. This term is used for all diseases which do not fall under the head of chronic diseases.

**ACUTITION**, among physicians, the sharpening or increasing the force of any medicine.

**ACYROLOGIA**, signifies an improper word, phrase, or expression.

**AD**, a Latin preposition, originally signifying *to*, and frequently used in composition both with and without the *d*, to express the relation of one thing to another.

**Ad bestias**, in antiquity, is the punishment of criminals condemned to be thrown to wild beasts.

**Ad bminem**, in logic, a kind of argument drawn from the principles or prejudices of those with whom we argue.

**Ad lador**, is antiquity, a sentence upon criminals among the Romans, whereby they were condemned to entertain the people either by fighting with wild beasts, or with one another, and thus executing justice upon themselves.

**Ad metallis**, in antiquity, the punishment of such criminals as were condemned to the mines, among the Romans; and therefore called *Metallici*.

**Ad quiddities**, among schoolmen. See **QUIDDITIES**.

**Ad valorem**, a term chiefly used in speaking of the duties or customs paid for certain goods: The duties on

some articles are paid by the number, weight, measure, tale, &c. and others are paid *ad valorem*, that is, according to their value.

**ADA**, a large town of Asia, inhabited chiefly by Armenians.

**ADACA-MANGEN**, in botany, a synonyme of the sphaeranthus. See **SPHAERANTHUS**.

**ADAGE**, a proverb, or short sentence, containing some wise observation or popular saying.

**ADAGIO**, in music, an Italian adverb, signifying *softly, leisurely*; and is used to denote the slowest of all times, except the grave.

**ADAJA**, a river in Spain which falls into the Duro.

**ADALIDES**, in the Spanish policy, are officers of justice for matters touching the military forces, especially on expeditions.

**ADAMANT**, a name sometimes given to the diamond. See **DIAMOND**. It is likewise applied to the scoria of gold, the magnet, &c.

**ADAMANTIC**, in church history, a name given to the followers of Origen, surnamed *Adamantius*.

**ADAMBOE**, in botany, a synonyme of the ipomoea campanulata, an Indian plant, belonging to the pentandria monogynia class. See **IPOMOEA**.

**ADAMI pomum**, or *Adam's apple*, in botany, an obsolete name of a species of the citrus or orange. See **CITRUS**.

**ADAMI pomum**, in anatomy, the convex part of the first cartilage of the larynx. See **ANATOMY**, Part VI.

**ADAMIC earth**, a name given to common red clay, alluding to that species of earth of which the first man is supposed to have been made.

**ADAMITES**, in church history, a name sometimes used for the descendants of Adam by Seth, who are more usually called *Sethites*. But the name *Adamites* is more particularly used, by ecclesiastical writers, for a sect of ancient heretics, who took upon them to imitate the nakedness of Adam, and pretended to be reinstated in his original innocence.

**ADAMSHIDE**, a district of the circle of Rastenburg, belonging to the King of Prussia, which, with Dombroeken, was bought, in 1737, for 42,000 dollars.

**ADAM'S peak**, a high mountain of the E: Indies, in the island of Ceylon, on the top of which they believe the first man was created; and there is the shape of a man's foot, cut out of the rock, about five or six feet in length, which they pretend is the print of his foot, 80. 50. E. long. 55. lat.

**ADANA**, an ancient town of Natolia, with a bishop's see. It stands on the river Choquen, 25 miles N. E. of Tarsus, 36. 25. long. 38. 10. lat.

**ADANSONIA**, in botany, a genus of the monadelphia polyandria class. It is a native of Senegal and Egypt.

**ADAOUS**, or *Adows*, a people of Guinea in Africa.

**ADAPTERS**, in chemistry, machines for fitting a recipient to the capital. See **CHEMISTRY**.

**ADAR**, the name of a Hebrew month, answering to the end of February and beginning of March, the 12th of their sacred, and 6th of their civil year. On the 7th

- 7th day of it, the Jews keep a fast for the death of Moses; on the 13th, they have the fast of Esther; and on the 14th, they celebrate the feast of Purim, for their deliverance from Haman's conspiracy.
- ADARCE**, a kind of concremented salts found on reeds and other vegetables, and applied by the ancients as a remedy in several cutaneous diseases.
- ADARCON**, in Jewish antiquity, a gold coin mentioned in scripture, about the value of which authors are not agreed.
- ADARÉ**, a small town of Ireland, in the county of Limerick.
- ADARME**, in commerce, a small weight in Spain, which is also used at Buenos-Aires, and in all Spanish America. It is the 16th part of an ounce, which at Paris is called the *demi-gros*. But the Spanish ounce is seven per cent. lighter than that of Paris. Stephens renders it in English by a *dram*.
- ADARTICULATION**, in anatomy, the same with diarthrosis. See **DIARTHROSIS**.
- ADATAIS**, **ADATIS**, or **ADATYS**, in commerce, a muslin or cotton-cloth, very fine and clear, of which the piece is ten French ells long, and three quarters broad. It comes from the E. Indies; and the finest is made at Bengal. See **MUSLIN**.
- ADCHER**, in the materia medica, a name given by some to the schœnanth. See **SCŒNANTH**.
- ADCORDABILES denarii**, in ancient law-books, is money paid by the vassal to his lord, in the nature of a fine, upon selling or exchanging a feud.
- ADCRESCENTES**, among the Romans, denoted a kind of soldiery, entered in the army, but not yet put on duty; from these the standing forces were recruited. See **ACCENSI**.
- ADDA**, in geography, a river of Switzerland and Italy, which rises in mount Braulio, in the country of the Grisons, and passing through the Valteline, traverses the lake Como and the Milanese, and falls into the Po, near Cremona.
- ADDACE**, in natural history, a name the Africans give to the common antelope. See **GAZELLA**.
- ADDEPHAGIA**, in medicine, a term used by some physicians, for gluttony, or a voracious appetite.
- ADDER**, in zoology, a vulgar name for the **VIPER**; which see.
- ADDERS-TONGUE**, in botany, the English name of the ophioglossum. See **OPHIOGLOSSUM**.
- ADDER-WORT**, in botany, the English name of the polygonum bistata. See **POLYGONUM**.
- ADDEXTRATORES**, in the court of Rome, the pope's mitre-bearers, so called according to Ducange; because they walk at the pope's right-hand, when he rides to visit the churches.
- ADDICE**, or **ADZE**, a kind of crooked ax used by ship-wrights, carpenters, coopers, &c.
- ADDICTI**, in antiquity, a kind of slaves, among the Romans, adjudged to serve some creditor whom they could not otherwise satisfy, and whose slaves they became till they could pay, or work out the debt.
- ADDICTION**, among the Romans, was the making over goods to another, either by sale, or by legal sentence; the goods so delivered were called *bona addicta*. Debtors were sometimes delivered over in the same manner; and thence called *servi addicti*.
- ADDICTIO in diem**, among the Romans, the adjudging a thing to a person for a certain price, unless by such a day the owner, or some other, give more for it.
- ADDITAMENT**, a term sometimes used by chemists and physicians for the addition of any new ingredient to increase the strength of a menstruum or composition.
- ADDITION**, is the joining together or uniting two or more things, or augmenting a thing by the accession of others thereto.
- ADDITION**, in **ARITHMETIC**, **ALGEBRA**, **LOGARITHMS**, &c. see these articles.
- ADDITION of ratios**, a term sometimes used for composition of ratios.
- ADDITION**, in music, a dot marked on the right side of a note, signifying that it is to be sounded or lengthened half as much more as it would have been without such mark.
- ADDITION**, in law, is that title or designation which is given to a man, over and above his proper name and surname, to shew of what estate, degree, occupation, or place he is.
- ADDITIONS**, in heraldry, some things added to a coat of arms, as marks of honour; and therefore directly opposite to abatements. Among additions we reckon **BORDURE**, **QUARTER**, **CANTON**, **GYRON**, **PILE**, &c. See these articles.
- ADDITION**, in distillery, a general name given to such things as are added to the wash or liquor while fermenting, to increase the vinosity and quantity of the spirit, or give it a particular relish.
- ADDITIVE**, in general, something to be added. Thus, mathematicians speak of *additive ratios*, astronomers of *additive equations*, &c.
- ADDOU**, one of the Maldivian islands.
- ADDRESS**, a term often used to express the skill and propriety with which an affair is conducted or managed.
- An ADDRESS*, in a particular acceptation, is a congratulation, petition, or remonstrance, presented to a superior, especially to the king.
- ADDUCENT muscles**, or **ADDUCTORS**. See **ADDUCTOR**.
- ADDUCTION**, in anatomy, the motion or action of the adducent muscles.
- ADDUCTOR**, in anatomy, the names of all muscles which pull one part of the body towards another. See **ANATOMY**, Part II.
- ADEA**, in geography, a province of Annian, on the eastern coast of Africa, called also *Adel*.
- ADEB**, a large and uncertain Egyptian weight, used chiefly for rice.
- ADEL**, or **ADEA**, in geography, a kingdom of Africa, called also *Zeila*, from its capital town. It lies on the S. coast of the strait of Babelmandel. There is seldom any rain here, and yet the country is fruitful, it being well watered with rivers. It abounds with wheat,

- wheat, millet, frankincense, and pepper. Their religion is the Mahometan.
- ADEL-*fish***, an obsolete name of the *salmo albula*, belonging to the order of abdominales. See **SALMO**.
- ADEL-ODAGAM**, in botany, a synonyme of the *justicia bivalvis*. See **JUSTICIA**.
- ADELIA**, in botany, a genus of the diœcia monadelphia class. Of this genus there are three species; the *bernardia*, a native of America; and the *ricinella* and *acidoton*, both natives of Jamaica.
- ADELPHIANI**, in church history, a sect of ancient heretics, so called from their leader *Adelphius*. They keep the sabbath as a fast.
- ADELSCALC**, in antiquity, a servant of the king; from the German, *adel*, noble, and *scalc*, a servant. They seem to have been the same with *royal thanes* among the Saxons, and the *ministri regis* in ancient charters.
- ADELSPERG**, a small town of Germany, in lower Carniola.
- ADEMPTION**, in law, is the revocation of a donation, or grant, either directly by a deed or writ, or indirectly by otherwise disposing of the subject of it. See **RESCISSIO**.
- ADEN**, formerly a rich and considerable town of Arabia the Happy. It is seated by the sea-side, a little eastward of the straits of Bebelmandel.
- ADENANTHERA**, in botany, a genus of the decandria monogynia class. There are only two species of this plant, the *pavonina*, and the *falcataria*, both natives of India.
- ADENBURG**, or **ALDENBURG**, in geography, a town of Westphalia, and in the dutchy of Burg, subject to the Elector Palatine. It is 12 miles N. E. of Cologne, and 17 W. of Bonn, 7. 25. E. long. 51. 2. lat.
- ADENDUM**, a small town of Africa, in the kingdom of Fez.
- ADENOGRAPHY**, that part of anatomy which treats of the glandular parts.
- ADENOIDES**, in anatomy. See **PROSTATES**.
- ADENOLOGY**. See **ADENOGRAPHY**.
- ADENOS**, a kind of cotton otherwise called *marine cotton*. It comes from Aleppo by the way of Marseilles, where it pays 20 per cent. duty, according to the tariff of the year 1766. Its valuation, according to the same tariff, is 76 livres 16 sols.
- ADENOSE abscess**, a term sometimes used for a hard tumour resembling a gland.
- ADEONA**, in mythology, the name of a goddess invoked by the Romans when they set out upon a journey.
- ADEPHAGIA**, in mythology, the goddess of gluttony, to whom the Sicilians paid religious worship.
- ADEPS**, in anatomy, the fat found in the abdomen. It also signifies animal-fat of any kind.
- ADEPTS**, a term among alchemists for those who pretended to have found out the panacea or philosophers-stone.
- ADEQUATE**, something equal to or exactly corresponding with another.
- ADEQUATE idea**, signifies a distinct or perfect conception of all the qualities of any object.
- ADERBERG**, a town of Pomerania, situate on the Oder.
- ADERBIGAN**, a province of Persia, bounded on the N. by Armenia Proper, on the S. by Irac-Agemi, on the E. by Ghilan, and on the W. by Curdistan. The principal town is Tauris, from 42. to 48. long. from 36. to 39. lat.
- ADERNO**, a small place in the Val di Demona in the kingdom of Sicily, 15. 25. E. long. 28. 5. lat.
- ADESSENARIANS**, **ADESSENARIII**, in church-history, a sect of Christians, who hold the real presence of Christ's body in the eucharist, though not by way of transubstantiation. They differ considerably as to this presence, some holding that the body of Christ is in the bread; others, that it is about the bread; and others, that it is under the bread.
- ADEFECTED equation**. See **ALGEBRA**.
- ADFILIAION**, a Gothic custom, whereby the children of a former marriage are put upon the same footing with those of the second. This is also called *unio prolium*, and still retained in some parts of Germany.
- ADHATODA**, in botany, a synonyme of a species of *ruelia*, *acanthus*, and of two species of *justicia*.
- Action of ADHERENCE**, in Scots law, an action competent to a husband or wife, to compel either party to adhere, in case of desertion. See **LAW**, title, *Marriage*.
- ADHERGAT**, a town of Syria, near the frontiers of Arabia.
- ADHESION**, implies the sticking or adhering of two bodies together.
- ADHESION**, in logic, signifies tenaciousness to an argument, without regard to any evidence of its truth.
- ADHESION**, in anatomy, a term for one part sticking to another, which in a natural state are separate.
- ADHOA**, in ancient customs. See **RELIEF**.
- ADJA**, or **ADGA**, a town of Guinea on the coast of Fantin.
- ADJACENT**, an appellation given to such things as are situate near, or adjoining to each other.
- ADIANTHUM**, in botany, a genus of the cryptogamia filices, of which there are 19 species, and only two of them natives of Britain, *viz.* the *adanthum capillus veneris*, or true maiden-hair, and the *trapeziforme*, or shining maiden-hair.
- ADIAPHORISTS**, **ADIAPHORISTÆ**, or **ADIAPHORISTES**, in church-history, a name importing lukewarmness, given, in the sixteenth century, to the moderate Lutherans, who embraced the opinions of Melancthon, whose disposition was vastly more pacific than that of Luther.
- ADJAZZO**, in geography, a handsome town and castle of Corsica in the Mediterranean, with a bishop's see, and a good harbour. It is populous, and fertile in wine. Some call it *Agaccio*. It is 27 miles S. W. of Corte, 8. 53. E. long. 41. 54. lat.
- ADJECTIVE**, in grammar, when joined to a substantive, imports some quality, or accident, or circumstance belonging to that substantive.
- ADIGE**, in geography, a river in Italy, which taking its

its rife S. of the lake Glace, among the Alps, runs S. by Trent, then E. by Verona in the territory of Venice, and falls into the gulph of Venice, N. of the mouth of the Po.

**ADJOURNMENT**; the word imports putting off something to another day or time.

**ADIPOSE**, a term used by anatomists for any cell, membrane, &c. that is remarkable for its fatness.

**ADVIRBEITSAN**, in geography, a province of Persia, in Asia, and part of the ancient Media. It is bounded on the N. by the province of Shirvan, on the S. by Irac-Agemi and Curdistan, on the E. by Gilan and the Caspian sea, and on the W. by Turcomania.

**ADIT**, in general, signifies the passage to, or entrance of any thing, as the adit of a mine, &c.

**ADJUDICATION**, in Scots law, the name of that action by which a creditor attaches the heritable estate of his debtor, or his debtor's heir, in order to appropriate it to himself, either in payment or security of his debt; or, that action by which the holder of an heritable right, labouring under any defect in point of form, may supply that defect. See **LAW**, title, *Comprisings and adjudications*.

**ADJUNCT**, something added or joined to another. In rhetoric and grammar, they signify certain words or things added to others, to amplify or augment the force of the discourse.

**ADJUTANT**, in the military art, is an officer whose business it is to assist the major. Each battalion of foot and regiment of horse has an adjutant, who receives the orders every night from the brigade-major; which, after carrying them to the colonel, he delivers out to the serjeants. When detachments are to be made, he gives the number to be furnished by each company or troop, and assigns the hour and place of rendezvous. He also places the guards, receives and distributes the ammunition to the companies, &c. and by the major's orders, regulates the prices of bread, beer, and other provisions.—The word is sometimes used by the French for an *aid-du-camp*.

**ADJUTANTS-general**, among the Jesuits, a select number of fathers, residing with the general of the order, each of whom has a province or country assigned him, as England, Holland, &c. and their business is to inform the father-general of state-occurrences in such countries.

**ADJUTORIUM**, a term used by physicians for any medicine in a prescription but the capital one.

**ADJUTORIUM**, in anatomy, the same with the humerus or shoulder-blade. See **HUMERUS**.

**ADLE-EGGS**, such as have not received an impregnation from the semen of the cock.

**ADLOCUTION**, in Roman antiquity, is chiefly understood of speeches made by Roman generals, to their armies, to animate them with courage, before a battle.

**ADMINICLES**, in Scots law, signifies any writing or deed referred to by a party in an action of law, for proving his allegations or assertions.

**ADMINICLES**, among antiquarians, the ornaments wherewith Juno is represented on medals.

**ADMINICULATOR**, an ancient officer of the church, whose business it was to attend to, and defend the cause of widows, orphans, and others destitute of help.

**ADMINISTRATION**, in general, the government, direction, or management of affairs, and particularly the exercise of distributive justice; among ecclesiastics it is often used to express the giving or dispensing the sacraments, &c.

**ADMINISTRATION**, is also the name given by the Spaniards in Peru, to the staple magazine, or warehouse, established at Callao, a small town on the S. Sea, which is the port of Lima, the capital of that part of S. America, and particularly of Peru. The foreign ships, which have leave to trade along that coast, are obliged to unload here, paying 13 *per cent.* of the price they sell for, if the cargo be entire, and even 16 *per cent.* if otherwise; besides which they pay 3 *per 1000*, duty for consulship, and some other small royal rights and claims.

**ADMINISTRATION**, a term used by anatomists for the art of dissecting with propriety.

**ADMINISTRATOR**, in Scots law, a person legally empowered to act for another whom the law presumes incapable of acting for himself. Thus tutors or curators are sometimes styled *administrators in law* to pupils, minors, or fatuous persons. But more generally the term is used to imply that power which is conferred by the law upon a father over the persons and estates of his children during their minority. See **LAW**, title, *Minors, and their tutors and curators*.

**ADMINISTRATOR**, is sometimes used for the president of a province; for a person appointed to receive, manage, and distribute the revenues of an hospital or religious house; for a prince who enjoys the revenues of a secularized bishoprick; and for the regent of a kingdom, during a minority of the prince, or a vacancy of the throne.

**ADMINISTRATRIX**, a woman who acts as administrator.

**ADMIRABILIS**, in botany, a synonyme of the mirabilis. See **MIRABILIS**.

**ADMIRABILIS sal**, the same with Glauber's salt. See **GLAUBER'S SALT**.

**ADMIRAL**, in maritime affairs, a great officer who commands the naval forces of a kingdom or state.

**High Admiral**, in the law of Scotland, a judge invested with supreme jurisdiction in all maritime causes within Scotland. See **LAW**, title, *Supreme judges, and courts of Scotland*.

**ADMIRAL** also denotes the commander in chief of a single fleet or squadron; or, in general, any flag-officer whatever. In the British navy, besides the admiral who commands in chief, there are the vice-admiral, who commands the second squadron; and the rear-admiral, who commands the third. The admiral carries his flag at the main-top-mast-head; the vice-admiral at the fore-top-mast-head; and the rear-admiral at the mizen-top-mast-head. See **FLAG**.

**Vice-Admiral** likewise denotes an officer invested with the jurisdiction of an admiral, within a certain district. There are a number of such in G. Britain.

**ADMIRAL**,



*Fig. 1.* ADONIS APPENINA



*Fig. 2.* ALAUDA or Lark





**ADMIRAL** is also an appellation given to the most considerable ship of a fleet of merchant-men, or of the vessels employed in the cod-fishery of Newfoundland. This last has the privilege of chusing what place he pleases on the shore to dry his fish; gives proper orders, and appoints the fishing places to those who come after him; and as long as the fishing-season continues, he carries a flag on his main-mast.

**ADMIRAL**, in zoology, the English name of a species of the voluta, a shell fish belonging to the order of vermes testacea. See **VOLUTA**.

*High Court of ADMIRALTY*, in Scotland, the court in which the high-admiral is judge. See **ADMIRAL**.

**ADMIRATION**, in general, denotes surprise, wonder, or astonishment at any extraordinary event. Sometimes also it signifies the expression of wonder.

**ADMISSION**, among ecclesiastical writers, is the act of a bishop's allowing a clerk to be properly qualified for serving a cure.

**ADMITTENDO clerico**, in the English law, a writ granted to a person who has recovered his right of presentation against the bishop, &c. in the common pleas, by which the bishop, or metropolitan is ordained to admit his clerk.

**ADMITTENDO in socium**, in the English law, a writ for the association of certain persons to justices of assize formerly appointed.

**ADMONITION**, in ecclesiastical discipline, is a formal warning of an offender of his irregularities, and advising him to reform.

**ADMONITIO fustium**, among the Romans, a military punishment, not unlike our whipping, only it was performed with vine-branches.

**ADMORTIZATION**, in the feudal customs, the reduction of the property of lands or tenements to mortmain. See **MORTMAIN**.

**ADNATA**, in anatomy, one of the coats of the eye, which is also called *conjunctiva* and *albuginea*. See **ANATOMY**, Part VI.

**ADNATA**, is also used for any hair, wool, or the like, which grows upon animals or vegetables.

**ADNOUN**, a term used by some grammarians for an adjective.

**AD ois**, implied the highest degree of perfection, among ancient philosophers.

**ADOLESCENCE**, the flower of youth, or time of growth in the human species, commencing at infancy, and terminating in manhood.

**ADOLPH Fredrick's Schacht**, a silver-mine in Sweden, which, from 1742 to 1747, produced a great deal of silver.

**ADOM**, in geography, a populous village in the province of Stuhl-Weissenberg, belonging to Hungary. It lies in a fruitful country, towards the river Danube, 19. 20. long. 47. 30. lat.

**ADONAI**, one of the names of the Supreme Being in the scriptures. The proper meaning of the word is *my lords*, in the plural number, as *Adoni* is *my lord* in the singular.

**ADONIA**, in mythology, festivals in honour of Venus,

and in memory of Adonis, with whom she is said to have been in love.

**ADONIAS**, in botany, an obsolete name of the anemone. See **ANEMONE**.

**ADONIDES**, in botany, a name given to botanists who described or made catalogues of plants cultivated in any particular place.

**ADONION**, in botany, an obsolete name of a species of southernwood.

**ADONIS**, in zoology. See **EXOCORBUS**.

**ADONIS**, in botany, a genus of the polyandria polygynia class. The English names are, adonis-flower, pheasant's eye, red maithes, or red morocco. The calix of this genus is pentaphyllous, the petals are five, and the seeds are naked. There are five species of the adonis, viz. the *estivalis*, *autumnalis*, *vernalis*, *appennina*, and *capensis*; none of which are natives of Britain, excepting the *autumnalis*. See Plate III. fig. 1. which represents the *adonis appennina*.

**ADONIS potio**, in antiquity, an ancient beverage made of wine, mixed with flower of roasted adon. It was the same with cyceon.

**ADOPTIANI**, in church history, a sect of ancient heretics, followers of Felix of Urgel, and Elipand of Toledo, who, towards the end of the eighth century, advanced the notion, that Jesus Christ, in his human nature, is the Son of God, not by nature, but by adoption.

**ADOPTION**, a solemn act whereby any one takes another man's son into his family, and makes him his heir, investing him with all the rights and privileges of a son.

**ADOPTIVE**, in general, signifies any thing adopted. Thus we say, *adoptive children*, &c.

**ADOPTIVE arms**, in heraldry, or, *arms of adoption*, those which a person enjoys by the gift or concession of another, and to which he was not otherwise intitled.

**ADOPTIVI**. See **ADOPTIANI**.

**ADORATION**, is the homage and submission due to the Supreme Being.

**ADOSSEE**, in heraldry, signifies two figures or bearings, being placed back to back. Thus the arms of the dutchy of Bar are two bars *adoffee*, or back to back.

**ADOUR**, the name of a river of France, which rises in the mountains of Bigorre, and running N. by Tarbes through Gascony, afterwards turns E. and, passing by Dax, falls into the bay of Biscay, below Bayonne.

**ADOXA**, or **TUBEROSE MOSCHATIL**, in botany, a genus of the octandria tetragynia class. There is only one species of the *adoxa*, which is a native of Britain and other parts of Europe.

**ADPERCEPTION**, a term used by Leibnitz for the act whereby the mind becomes conscious of its perceptions.

**AD pondus omnium**, among physicians, an abbreviation in their prescriptions, signifying that the last mentioned ingredient is to weigh as much as all the rest together.

**AD quod damnum**, in the English law, a writ directed to the sheriff, commanding him to enquire into the damage which may befall from granting certain privileges to a place, as a fair, market, or the like.

**ADRA**,

- ADRA**, in geography, a sea-port town of Spain, in the Kingdom of Granada, 37 miles S. E. of Granada, and 12 S. W. of Almeria, 1. 10. W. long. 36. 0. lat.
- ADRACANTH**. See **TRAGACANTH**.
- ADRACHNE**, in botany, an obsolete name of a species of arbutus. See **ARBUTUS**.
- ADRAMMELECH**, in antiquity, or mythology, a deity worshipped by the inhabitants of Sepharvaim, a people planted in the Holy Land by the kings of Assyria, after Salmanazar had taken Samaria, and put a final period to the kingdom of Israel. The worshippers of Adrammelech burnt their children in the fire to the honour of that idol. The name is Persian, and signifies *the magnificent king*.
- ADRIUNE**, in botany, an obsolete name of the cyclamen. See **CYCLAMEN**.
- ADROBE**, the name of two rivers in that part of Asiatic Tartary which is subject to Moscow: They both fall into the Wolga beneath Cazan.
- ADSCRIPTS**, a term used by some mathematicians for the natural tangents. See **TANGENT**.
- ADSIDELLA**, in antiquity, the table at which the flames sat during the sacrifices.
- ADSTAT**, a small town belonging to Denmark in the island of Iceland, not far from Holar.
- ADSTRICTION**, among physicians, a term used to denote the rigidity of any part.
- ADVANCE**, in the mercantile style, denotes money paid before goods are delivered, work done, or business performed.
- ADVANCED ditch**, in fortification, is that which surrounds the glacis or esplanade of a place.
- ADVANCED guard**, or *vanguard*, in the art of war, the first line or division of an army, ranged, or marching in order of battle; or, it is that part which is next the enemy, and marches first towards them.
- ADVANCED guard**, is more particularly used for a small party of horse stationed before the main-guard.
- ADVANCER**, among sportsmen, one of the starts, or branches of a buck's attire, between the back antler and the palm.
- ADUAR**, in the Arabian and Moorish customs, a kind of ambulatory village, consisting of tents, which these people remove from one place to another, as suits their conveniency.
- ADVENT**, in the kalendar, properly signifies the approach of the feast of the Nativity. It includes four fundays, which begin on St Andrew's day, or on the Sunday before or after it. During advent, and to the end of the octaves of Epiphany, the solemnizing of marriage is forbid, without a special licence.
- ADVENTITIOUS**, an epithet applied to any thing that is accidental or fortuitous.
- AD VENTREM *inspiciendum***, in law, a writ by which a woman is to be searched whether she be with child by a former husband, on her withholding of lands from the next, failing issue of her own body.
- ADVENTURE**, in a general sense, some extraordinary or accidental event. It also denotes a hazardous or difficult undertaking.
- Bill of ADVENTURE**, among merchants, a writing signed by a merchant, testifying the goods mentioned in it to be shipped on board a certain vessel belonging to another person, who is to run all hazards; the merchant only obliging himself to account to him for the produce.
- ADVENTURER**, in a general sense, denotes one who hazards something.
- ADVERB**, in grammar, a word joined to verbs, expressing the manner, time, &c. of an action: thus, in the phrase, *he was warmly attached to the interest of his master*, the word *warmly* is an adverb. See **GRAMMAR**.
- ADVERSARIA**, among the ancients, a book of accounts, not unlike our journals, or day-books. It is more particularly used for a kind of common-place-book. See **COMMON-PLACE-BOOK**.
- ADVERSARY**, a person who is an enemy to, or opposes another.
- ADVERSATIVE**, in grammar, a word expressing some difference between what goes before and what follows it. Thus, in the phrase, *he is an honest man, but a great enthusiast*, the word *but* is an adversative conjunction.
- ADVERSATOR**, in antiquity, a servant who attended the rich in returning from supper, to give them notice of any obstacles in the way, at which they might be apt to stumble.
- ADVERTISEMENT**, in a general sense, denotes any information given to persons interested in an affair; and is more particularly used for a brief account of an affair inserted in the public papers, for the information of all concerned.
- ADULT**, an appellation given to any thing that is arrived at maturity: Thus we say, an adult person, an adult plant, &c. Among civilians, it denotes a youth between fourteen and twenty-five years of age.
- ADULTERATION**, the act of debasing, by an improper mixture, something that was pure and genuine.
- ADULTERY**, an unlawful commerce between one married person and another, or between a married and unmarried person. See **SCOTS LAW**, titles, *Marriage, and Crimes*.
- ADVOCATE**, among the Romans, a person who undertook the defence of causes. The term is still kept up in all countries where the civil law obtains.
- King's ADVOCATE**, is the principal crown-lawyer in Scotland. His business is to act as a public prosecutor, and to plead in all causes that concern the crown; but particularly in such as are of a criminal nature. The office of King's advocate is not very ancient: It seems to have been established about the beginning of the 16th century. Originally he had no power to prosecute crimes without the concurrence of a private party; but in the year 1597, he was empowered to prosecute crimes at his own instance.
- Faculty of ADVOCATES**, in Scotland, a respectable body of lawyers, who plead in all causes before the Courts of Session, Justiciary, and Exchequer. They are also intitled to plead in the house of peers, and other supreme courts in England.
- In the year 1660, the faculty founded a library upon

upon a very extensive plan, suggested by that learned and eminent lawyer Sir George M'Kenzie of Rosehaugh, advocate to King Charles II. and King James VII. who enriched it with many valuable books. It has been daily increasing since that time, and now contains not only the best collection of law-books in Europe, but a very large and select collection of books on all subjects. Besides, this library contains a great number of original manuscripts, and a vast variety of Jewish, Grecian, Roman, Scots, and English coins and medals.

A candidate for the office of an advocate undergoes three several trials: The first is in Latin, upon the civil law and Greek and Roman antiquities; the second, in English, upon the municipal law of Scotland; and in the third, he is obliged to defend a Latin thesis, which is impugned by three members of the faculty. Immediately before putting on the gown, the candidate makes a short Latin speech to the lords, and then takes the oaths to the government and *de fideli*.

The faculty at present consists of above 200 members. As an advocate or lawyer is esteemed the gentlest profession in Scotland, many gentlemen of fortune take the degree of advocate, without having any intention of practising at the bar. This circumstance greatly increases their number, gives dignity to the profession, and enriches their library and public fund. It is from this respectable body, that all vacancies on the bench are generally supplied.

*Fiscal Advocate*, *fisci advocatus*, in Roman antiquity, an officer of state under the Roman Emperors, who pleaded in all causes wherein the *fiscus*, or private treasury, was concerned.

*Consistorial Advocates*, officers of the consistory at Rome, who plead in all oppositions to the disposal of benefices in that court; they are ten in number.

*Advocate of a city*, in the German polity, a magistrate appointed in the Emperor's name to administer justice.

*Bill of Advocation*, in Scots law, a writing drawn up in the form of a petition, whereby a party, in an action before an inferior court, applies to the supreme court, or court of Session, for calling the action from the inferior court before itself. See *LAW*, title, *Jurisdiction*, and *judges in general*.

*Letters of Advocation*, in Scots law, the decree or warrant of the court of Session upon cognisance of the facts set forth in the bill, drawn up in the form of a summons, and passing under the signet, discharging the inferior judge and all others from further procedure in the cause, and advocating it to itself. See *Bill of Advocation*.

*Advocatione decimarum*, a writ which lies for claiming a fourth part for tithes, or upwards, belonging to any church.

*ADVOUSON*, or *ADVOUZEN*. See *ADVOWZON*.

*ADVOU*, in law, signifies the patron of a church, or he who has a right to present to a benefice.

*Paramount ADVOWEE*, is used for the king, as being the highest patron.

*ADVOWING*. See *AVOWING*.

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*ADVOWTRY*, a term used in some old law-books for adultery.

*ADVOWZON*, in law, is the right of patronage, or presenting to a vacant benefice.

*ADUST*, among physicians, a term applied to the blood, &c. when too hot and fiery.

*ADUSTION*, among physicians, the same with inflammation.

*ADYTUM*, in pagan antiquity, the most retired and sacred place of their temples, into which none but the priests were allowed to enter.

*ADZEL*, a small town of Livonia, situated on the south-side of the river Aa, about ten German leagues south-west of Dorpt.

*ÆACEA*, in Grecian antiquity, solemn festivals and games celebrated at Ægina, in honour of Æacus; who, on account of his justice upon earth, was thought to have been appointed one of the judges in hell.

*ÆCHMALOTARCHA*, in Jewish antiquity, the title given to the principal leader or governor of the Hebrew captives residing in Chaldea, Assyria, and the neighbouring countries.

*ÆDES*, in Roman antiquity, besides its more ordinary signification of a house, likewise signified an inferior kind of temple, consecrated to some deity.

*ÆDICULA*, a term used to denote the inner part of the temple, where the altar and statue of the deity stood.

*ÆDILATE*, the office of ædile, sometimes called *ædilitate*. See the next article.

*ÆDILE*, in Roman antiquity, a magistrate whose business it was to superintend buildings of all kinds, but more especially public ones, as temples, aqueducts, high-ways, bridges, &c.

*ÆDITUUS*, in Roman antiquity, an officer belonging to the temples, who had the charge of the offerings, treasure, and sacred utensils. The female deities had a woman-officer of this kind called *æditua*.

*ÆGAGROPILA*, a ball composed of a substance resembling hair, generated in the stomach of the chamois-goat. This ball is of the same nature with those found in cows, hogs, &c.

*ÆGILETHRON*, in botany, an obsolete name of the mercurialis. See *MERCURIALIS*.

*ÆGIAS*, among physicians, a white speck on the pupil of the eye, which occasions dimness of sight.

*ÆGILOPS*, among physicians, a species of abscess. See *SURGERY*, title, *Of abscesses*, or *tumors*.

*ÆGILOPS*, in botany, a genus of the polygamia monœcia class. There are five species of this plant, which is a kind of grass, *viz.* the ovata, caudata, squarrosa, triuncialis, and incurvata, only the last of which is a native of Britain, and grows by the sea-shore. The English name is *sea-hard-grass*.

*ÆGINETIA*, in botany, a synonyme of a species of orobanche. See *OROBANCHE*.

*ÆGIPAN*, in heathen mythology, a denomination given to the god Pan, because he was represented with the horns, legs, feet, &c. of a goat.

*ÆGIS*, in heathen mythology, is particularly used for the shield or cuirass of Jupiter and Pallas.

*ÆGIUCHUS*, in heathen mythology, a surname of Jupiter,

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piter,

- piter, given him on account of his having been suckled by a goat.
- ÆGLEFINUS**, or **HADDOCK**, in ichthyology, a species of the gadus. See **GADUS**.
- ÆGOCEPHALUS**, in ornithology, an obsolete name of a species of tringa. See **TRINGA**.
- ÆGOCERAS**, in botany, an obsolete name of a species of oronis. See **ONONIS**.
- ÆGOCERATOS**, in botany, a synonyme of the hugonia. See **HUGONIA**.
- ÆGOLETHRON**, in botany, an obsolete name of the rhododendron hirsutum. See **RHODODENDRON**.
- ÆGONICHUS**, in botany, an obsolete name of the lithospermum. See **LITHOSPERMUM**.
- ÆGOPHTHALMUS**, a name given to any of the semipellucid gems with circular spots in them, resembling the eye of a goat.
- ÆGOFOGON**, in botany, an obsolete name of the tragapodon. See **TRAGAPODON**.
- ÆGOPODIUM**, a genus of the pentandria digynia class. There is but one species of this plant, which is a native of Britain and other parts of Europe. The English name is *herb-gerard, gout-wood, or asplenoid*.
- ÆGYPTIACUM**, in pharmacy, the name of several detergent ointments.
- ÆGYPTILLA**, the name of a stone variegated with different colours, and said to be capable of giving water the colour and taste of wine.
- ÆINAUTÆ**, in antiquity, a denomination given to the senators of Miletus, because they held their deliberations on board a ship, and never returned to land till matters had been agreed on.
- ÆLURUS**, in Egyptian mythology, the deity or god of cats; represented sometimes like a cat, and sometimes like a man with a cat's head.
- ÆNEATORES**, in Roman antiquity, a general name for the musicians of an army.
- ÆNIGMA**, denotes any dark saying, wherein some well-known thing is concealed under obscure language.
- ÆNIGMATOGRAPHY**, or **ÆNIGMATHOLOGY**, the art of resolving, or making ænigmas.
- ÆOLIC**, in a general sense, denotes something belonging to Æolis.
- ÆOLIC dialect**, among grammarians, one of the five dialects of the Greek tongue, agreeing in most things with the Doric dialect. See **DORIC**.
- ÆOLIC verse**, in prosody, a verse, consisting of an iambus, or spondee; then of two anapests, separated by a long syllable; and lastly, of another syllable. Such as,
- O stelliferi conditor orbis.*
- ÆOLIPILE**, a hollow metalline ball with a slender neck, or pipe; which after being filled with water, and a great degree of heat applied to it, the water issues out with great velocity in the form of an elastic vapour. See **PNEUMATICS**.
- ÆOLIS**, in ancient geography, a country lying upon the western coast of Asia Minor.
- ÆOLUS**, the god of the winds.
- ÆON**, signifies the age or duration of any thing.
- ÆON**, among the Platonists, was used to denote any virtue, attribute, or perfection.
- ÆON**, in mythology, the first woman, according to the Phœnician writers.
- ÆON**, among anatomists, an obsolete name for the spinal marrow.
- ÆONIAN**, in botany, an obsolete name of the sedum majus. See **SEDUM**.
- ÆRA**, in chronology, a series of years commencing from a certain fixed point of time, called an *epocha*; thus we say, the Christian æra, that is, the number of years elapsed since the birth of Christ. See **ASTRONOMY, Of the division of time**.
- ÆRA of Nabonassar**. See **NABONASSAR**.
- ÆRA of the Hegira**: See **HEGIRA**.
- ÆRARIUM**, in Roman antiquity, the treasury or place where the public money was deposited.
- ÆRARIUM privatum**, was the emperor's privy purse, or place where the moneys arising from his private patrimony were deposited.
- ÆRARIUS**, in a general sense, denotes any person employed in coining or managing the public monies.
- ÆRARIUS** was more particularly used by the Romans for a degraded citizen, whose name had been struck off the list of his century.
- The ærarii were so called on account of their being liable to all the taxes and other burdens of the state, without enjoying any of its privileges. Hence, *inter ararios referri*, was a more severe punishment than *tribu moveri*.
- AERIAL**, in a general sense, denotes something partaking of the nature of air; thus, aerial substance, aerial particles, &c.
- AERIANS**, in church-history, a branch of Arians, who, to the doctrines of that sect, added some peculiar dogmas of their own; as, that there is no difference between bishops and priests; a doctrine maintained by many modern divines, particularly of the presbyterian and reformed churches.
- AERICA**, in ichthyology, a synonyme of the clupea hœngus, or herring. See **CLUPPA**.
- Flos ÆRIS**, among alchemists, small scales procured from copper melted by a strong heat; it is sometimes used for ærugo or verdegis.
- AEROGRAPHY** signifies a description of the air, especially of its dimensions, and other most obvious properties; in which sense it differs but little from *aerology*, which is a scientific account of the nature and less obvious properties of air. See **PNEUMATICS**.
- AEROMANCY**, a species of divination performed by means of air, wind, &c. It is also used for the art of foretelling the various changes of the air and weather, by means of barometers, hygrometers, &c.
- AEROMETRY**, the art of measuring the motion, gravity, elasticity, rarefaction, condensation, &c. of air. See **PNEUMATICS**.
- AEROPHOBIA**, among physicians, signifies the dread of air.
- AEROPHYLACEA**, a term used by naturalists for caverns or reservoirs of air, supposed to exist in the bowels of the earth.

ERRA,

**ÆRRA**, a small town of Portugal, in the province of Estramadura, situated upon the river Zatas.

**AERESCHOT**, a town of the Dutch Netherlands, situated in Brabant, about fifteen miles eastward of Mechlin.

**ÆRUGINOUS**, in ornithology, the trivial name of a species of falco. See **FALCO**.

**ÆRUGINOUS**, an epithet given to such things are resemble or partake of the nature of the rust of copper.

**ÆRUGO**, properly signifies the rust of copper, or verdgris; but is applied indifferently to rust of any kind.

**ÆRUGO salis**, a kind of reddish slimy matter, separated from Egyptian *natrum*; probably a mixture of bitumen and a red earth.

**ÆRUSCATORRES**, in antiquity, a kind of strolling beggars, not unlike gypsies, who drew money from the credulous by fortune-telling, &c. It was also a denomination given to gripping exactors, or collectors of the revenue.

**AERY**, or **AIRY**, among sportsmen. See **AIRY**.

**ÆS**, properly signifies copper, or money coined of that metal. See **COPPER**.

**Æs flavum**, yellow copper, among the Romans, an appellation given to the coarser kinds of brass. See **BRASS**.

**Æs caldarium**, the name of a certain regulus of antimony, employed in preparing the fine blue colour called *smalt*.

**Æs ustum**, a preparation of copper, by exposing plates of it in a reverberatory furnace; till they crumble into a powder, which is called *æs ustum*. It is used for colouring glass, eating off dead flesh, or cleansing foul ulcers.

**ÆSALON**, in ornithology, an obsolete name of a species of falco. See **FALCO**.

**ÆSCH**, in ichthyology, an obsolete name of a species of salmo. See **SALMO**.

**ÆSCHYNOMENE**, in botany, a genus of the diadelphia decandria class. There are seven species of this genus, none of which are natives of Britain. The calix of the *æschynomene* is bilabiated, and the pod jointed. It is also a synonyme of several species of the mimosa, or sensitive plant. See **MIMOSA**.

**ÆSCULANUS**, or **ÆRES**, in mythology, a deity who presided over the coinage of copper-money.

**ÆSCULAPIUS's serpent**, or **COLUBER ÆSCULAPII**. See **COLUBER**.

**ÆSCULUS**, in botany, a genus of the heptandria monogynia class. There are only two species of it, *viz.* the *castanum*, and the *pavia*, both natives of India. The calix of the *æsculus* is monophyllous with five teeth; the corolla has five petals unequally coloured, and inserted into the calix.

**ÆSTIMATIO capitis**, a term met with in old law-books for a fine anciently ordained to be paid for offences committed against persons of quality, according to their several degrees.

**ÆSTIVAL**, in a general sense, denotes something connected with, or belonging to summer. Hence, æstival sign, æstival office, &c.

**ÆSTUARIA**, in geography, denotes an arm of the sea, which runs a good way within land. Such is the Bristol channel, and many of the friths of Scotland.

**ÆSTUARIES**, in ancient baths, were secret passages from the hypocaustum into the chambers. See **BATH**, and **HYPOCAUSTUM**.

**ÆSTUARY**, among physicians, a vapour-bath, or any other instrument for conveying heat to the body.

**ÆTH**, or **ATH**, a strong little town in the Austrian Netherlands, and province of Hainault, situated on the river Dender, about twenty miles S. W. of Brussels.

**ÆTHALE**, a term used by the ancients for the cadmia fornacum. See **CADMIÀ**.

**ÆTHALIES**, a name given by the Greeks to the sedum. See **SEDUM**.

**ÆTHER**, the name of an imaginary fluid, supposed by several authors, both ancient and modern, to be the cause of gravity, heat, light, muscular motion, sensation, and, in a word, of every phenomenon in nature. Anaxagoras maintained that æther was of a similar nature with fire; Perrault represents it as 7200 times more rare than air; and Hook makes it more dense than gold itself. Whoever has an inclination to know the various hypotheses concerning æther, may consult Shebbere, Perrault, Hook's posthumous works, *Art. Erud.* Lips. 1716, Bernouilli's *Cogitat. de gravitate ætheris*, &c. &c.

Before the method of philosophising by induction was known, the hypotheses of philosophers were wild, fanciful, ridiculous. They had recourse to æther, occult qualities, and other imaginary causes, in order to explain the various phenomena of nature: But since the days of the great Lord Verulam, who may be styled the parent of genuine philosophy, a contrary course has happily been followed. He convinced the world, that all knowledge must be derived from experiment and observation; and that every attempt to investigate causes by any other means must be unsuccessful. Since his time, the best philosophers have followed the tract which he pointed out. Boyle, Locke, Newton, Hales, and a few others, in little more than one century, have improved and extended science far beyond what the accumulated force of all the philosophers since the creation had been able to effectuate: A striking proof both of the comprehensive genius of Bacon, and of the solidity of his plan of investigation.

It must indeed be acknowledged, that there is a propensity in the human mind, which, unless it be properly restrained, has a direct tendency both to corrupt science, and to retard our progress in it. Not contented with the examination of objects which readily fall within the sphere of our observation, we feel a strong desire to account for things which, from their very nature, must, and ever will, elude our researches. Even Sir Isaac Newton himself was not proof against this temptation. It was not enough that he had discovered the nature of light and colours, the application of gravity to the motions of the heavenly bodies, &c. he must go further, and attempt to assign the cause of gravity itself. But, how does he proceed in this matter? Not in

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the way of experiment, which had led him to his former discoveries, but in the way of conjecture, which will never lead any man to truth. He had recourse to a subtle elastic æther, not much different from that of the ancients, and by it accounted for every thing he did not know, such as the cause of gravitation, muscular motion, sensation, &c.

Notwithstanding the reputation of Sir Isaac, philosophers have generally looked upon this attempt as the foible of a great man, or, at least, as the most useless part of his works; and accordingly peruse it rather as a dream or a romance, than as having any connection with science. But we are sorry to find, that some late attempts have been made to revive this doctrine of æther, particularly in a dissertation *De ortu animalium caloris*, published in May last.

As the revival of an old doctrine becomes in some measure a new one, we shall plead no other apology for inserting a specimen of the method of reasoning employed in this dissertation.

The author makes frequent use of a species of argument termed *dilemma* by logicians. For example, in the first part of the work, after endeavouring to prove that animal heat cannot be owing to fermentation, the motion of the fluids, and other causes that have usually been assigned, he draws this conclusion:—“If none of these causes are sufficient to produce the effect; therefore, by dilemma,” says he, “it must be sought for in the nature and action of the nerves.”—This is a new species of dilemma:—If the author had proved, that the cause of heat in animals could not possibly exist *any where*, but *either* in fermentation, the motion of the fluids, &c. or in the nerves, after having disproved its existence in all the rest, his conclusion in favour of the nerves would have been just; but, as he has not so much as attempted this, the conclusion is not only false, but ridiculous.

However, upon the authority of this dilemma, the author first gives what he calls a Compend of a *new* doctrine concerning the nerves, and then proceeds to inquire in what manner the nerves produce animal heat: He tells us, “That *thought* (*cogitatio*) and sensation depend upon impulses either on the extremities of the nerves, or the sensorium commune, and the consequent motions produced by these impulses: That these motions are so quick, as to be almost instantaneous: That as all motion is mechanical; therefore *thought*, sensation, and muscular motion, must likewise be mechanical: That such quick motions cannot be produced without the intervention of some extremely elastic power; and, as Sir Isaac Newton has shown, that the impulses which occasion the different sensations must be owing to an elastic power; therefore the muscular motions of animals must be occasioned by the oscillations of some elastic power.” But,” says he, “as this elastic power cannot exist in the solid nervous fibres, nor in any inelastic fluid; therefore, by *dilemma*, it must exist in an elastic fluid; and hence also, by the former *dilemma*, this elastic fluid must be seated, either in the nerves, or in their medullary substance.”

Here again the author calls Sir Isaac into his assistance.—“What confirms this opinion,” says he, “is the Newtonian æther, which pervades all nature, and which, with a few variations in its modification, Sir Isaac has shown to be the cause of cohesion, elasticity, gravity, electricity, magnetism, &c. in the following manner: 1. As the rays of light, when reflected, do not touch the solid parts of bodies, but are reflected a little before they reach them, it is plain that the æther not only fills the pores of bodies, but likewise floats upon their surfaces; and hence it becomes the cause of attraction and repulsion.—2. All metals, and inelastic fluids, are non-electrics; on the other hand, all solid bodies, metals excepted, are electrics, *i. e.* proper for accumulating æther. But æther, thus accumulated in such a variety of bodies, may produce various motions in the parts of these bodies, without inducing any change in the bodies themselves. Hence æther, with some variations in its modification, is sufficient to account for all the phenomena of electricity. 3. As iron, by accumulating æther around it, exhibits all the wonders of magnetism; so this magnetical æther is more analogous to the nervous æther of animals than any other kind of it. For, as the magnetical æther passes along iron without changing any part of the iron; so the nervous æther, in like manner, passes along the medullary substance of the nerves, and excites motion in any part that is continuous with them, without inducing any change in the nerves.—4. The irritability and life of plants, which very much resemble those in animals, cannot be explained by any inelastic cause, and must therefore be attributed to an ætherial one. Lastly, As the common æther is differently modified in each of the substances above taken notice of, and also produces various motions or effects peculiar to each, it likewise varies and has some peculiar qualities when residing in animal bodies; so that the nervous or animal æther is not exactly the same, but differs in some respects from those species of æther which give rise to cohesion, gravity, magnetism, electricity,” &c.

Having thus explained the nature and qualities of æther, our author starts a very important question, *viz.* “Whence is æther derived? and whether does it leave any body after having once got possession of it?” In answer to this, he observes, “That certain bodies have the power of collecting the electrical matter from every circumjacent body, and of accumulating it in their pores and on their surfaces, but do not suffer it again to transmigrate into any other body. There are other substances of an opposite nature, which do not accumulate the electric matter, but instantly allow it to pass into others, unless prohibited by an electric. Hence,” says he, “nothing more is necessary for substances of the former kind, but to be in such circumstances as allow them to accumulate the electric matter. In the same manner,” proceeds our author, “the nervous æther, which is diffused through every part of nature, flows

“flow copiously into the medullary part of the nerves, when no obstacle stands in its way: but, when once it has got there, it keeps firm possession, and never afterwards leaves it. Now,” says he, “a quantity of æther probably constitutes one of the staminal parts of animal bodies, and increases in proportion to their age and growth: For nothing is more ridiculous than to suppose that what is commonly called the nervous fluid can be daily wasted by labour and exercise, and daily repaired by a new secretion from the brain. To refute this vulgar notion, nothing more is necessary than to say, That it is one of Boerhaave’s theories, and must be false, as all Boerhaave’s other theories have been proved to be ill-founded! But æther is of a more fixed and determinate nature; whenever it gets possession of any substance, it never forsakes it, unless the texture and constitution of the body itself be changed. Hence,” continues our author, “the æther of an acid body remains as long as the body continues to be acid; the same observation holds with regard to the æther of an alkaline body: But, if these two be blended together into a neutral salt, the æther must likewise be changed into a neutral; and therefore, in the formation of the medullary or staminal part of animals, the æther which before belonged to, or had the properties of some other substance, is instantaneously changed into animal æther, and remains so till the dissolution of that animal.” Our author next observes, “That bodies require to be in a certain state or condition in order to the formation of an æther that is proper for them. This condition of bodies is called an excited state: Thus, as sulphur, when fluid, does not receive the electric matter, but, when solid, instantly receives it; in the same manner, the nerves, though properly formed, do not admit an æther adapted to their nature, unless they be in an excited state. Hence,” says he, “the æther of a dead, and that of a living person, are very different, although the texture and figure of the nerves be the same. The state necessary for constituting the æther of a living animal, seems to depend on heat and moisture; because these things are absolutely necessary in the constitution of life: And hence,” concludes our author, “the excited state of the nerves depends on heat and moisture. There are also certain circumstances,” says he, “which contribute to render the state of the nerves more or less apt for accumulating æther: A spasmodic fever, for example, renders the nerves of the whole body less pervious to the motion of the æther; and hence, in cases of this nature, health, and all the vital functions, must be injured.” “These,” our author observes, “are the outlines of a new doctrine concerning the nature and functions of the nerves;” and, upon this foundation, proceeds to give his new theory of animal heat. “From the foregoing reasoning,” says he, “the heat, as well as all the functions of animals, seem to be occasioned by the oscillations of the nervous æther betwixt the extremities of the sentient nerves

“and the brain, or, more properly, betwixt the brain and muscles. But electrical æther, as above observed, varies a little from common æther; all inelastic fluids, as was likewise formerly remarked, are non-electrics; and all solid bodies, metals excepted, are electrics: These circumstances,” says our author, “seem to be owing to the oscillations of the electric matter in bodies. In the same manner,” says he, “the nature of animals may be such, and the nerves may be so constituted, as to form an æther adapted to their nature, and to excite those oscillations which occasion animal heat. The wonderful effects of heat and cold upon the nerves,” continues our author, “confirms this theory: Every action, and even life itself, requires a certain degree of heat; for, as the heat of the external air is so variable, it was absolutely necessary that animal bodies should be endowed with the faculty of producing a degree of heat suited to their nature, independent of external circumstances: Hence we see the reason why the degree of heat so seldom varies in the same species of animals. However, although the nervous æther is always ready for exciting heat by its oscillations; yet, in order to bring about this effect successfully, external stimuli are necessary, otherwise the æther would be in danger of stagnating, which would occasion sleep, a palsy, and, last of all, death. The most permanent of these stimuli is the pulsation of the arteries; which is the reason why heat is so connected with the circulation of the blood, and why many authors have mistaken it for the true cause of animal heat.”

Our author now concludes with observing, “That by his theory, the varieties of heat in different parts of the body, the heat and flushing of the face from shame, and all the other phenomena of heat in animal bodies, admit of a better explanation, than by any other theory hitherto invented.”

Having thus given a pretty full account of an attempt to explain the most abstruse operations of nature, as nearly as possible in the very words of the author, we cannot deny ourselves the liberty of making a few observations.

To give a formal refutation of this author’s reasoning, is no part of our plan. It is, perhaps, wrong to say that he has reasoned; for the whole hypothetical part of his essay is a mere jarrago of vague assertions, non-entities, illogical conclusions, and extravagant fancies. His æther seems to be an exceedingly tractable sort of substance: Whenever the qualities of one body differ from those of another, a different modification of æther at once solves the phenomenon. The æther of iron must not, to be sure, be exactly the same with the nervous æther, otherwise it would be in danger of producing sensation in place of magnetism. It would likewise have been very improper to give the vegetable æther exactly the same qualities with those of animal æther; for, in such a case, men would run great risk of striking root in the soil, and trees and hedges might eradicate and run about the fields. Nothing can be more ludicrous than to see

a writer treating a mere *ens rationis* as familiarly as if it were an object of our senses: The notion of compounding the æther of an *acid* and that of an *alkali*, in order to make a *neutral* of it, is completely ridiculous. But if men take the liberty of substituting *names* in place of *facts* and *experiments*, it is an easy matter to account for any thing.

By this method of philosophising, obscurity is for ever banished from the works of nature. It is impossible to gravel an ætherial philosopher. Ask him what questions you please, his answer is ready:—"As we cannot find the cause *any where* else; ergo, by dilemma, it must be owing to æther!" For example, ask one of those sages, What is the cause of gravity? he will answer, 'Tis æther! Ask him the cause of thought, he will gravely reply, "The solution of this question was once universally allowed to exceed the limits of human genius: But now, by the grand discoveries we have lately made, it is as plain as that three and two make five:—Thought is a mere *mechanical* thing, an evident effect of certain motions in the brain produced by the *oscillations* of a subtle elastic fluid called æther!" This is indeed astonishing!

Such jargon, however, affords an excellent lesson to the true philosopher. It shows to what folly and extravagance mankind are led, whenever they deviate from experiment and observation in their inquiries into nature. No sooner do we leave these only faithful guides to science, than we instantly land in a labyrinth of nonsense and obscurity, the natural punishment of folly and presumption.

When endeavouring to account for that propensity in the human mind which prompts us to attempt the solution of things evidently beyond our reach, we recollected a passage in Swift's works, which explains it in the most satisfactory manner.

"Let us next examine (says the Dean) the great introducers of new schemes in philosophy, and search till we can find from what faculty of the soul the disposition arises in mortal man, of taking it into his head to advance new systems, with such an eager zeal, in things agreed on all hands *impossible to be known*; from what feeds this disposition springs, and to what quality of human nature these grand innovators have been indebted for their number of disciples; because it is plain, that several of the chief among them, both *ancient and modern*, were usually mistaken by their adversaries, and indeed by all except their own followers, to have been persons crazed, or out of their wits; having generally proceeded, in the common course of their words and actions, by a method very different from the vulgar dictates of *unrefined reason*; agreeing, for the most part, in their several models, with their present undoubted successors in the *Academy of modern Bealam*. Of this kind were *Epicurus, Diogenes, Apollonius, Lucretius, Paracelsus, Des Cartes*, and others; who, if they were now in the world, tied fast, and separated from their followers, would, in this *undistinguishing* age,

"incur manifest danger of *phlebotomy*, and *whips*, and *chains*, and *dark chambers*, and *straw*. For what man, in the natural state or course of thinking, did ever conceive it in his power to reduce the notions of all mankind exactly to the same length, and breadth, and height of his own? Yet this is the first *humble and civil* design of all innovators in the empire of reason.—Now, I would gladly be informed, how it is possible to account for such imaginations as these in particular men, without recourse to my *phenomenon* of vapours, (*i. e.* æther), ascending from the lower faculties to overhadow the brain, and there distilling into conceptions, for which the narrowness of our mother-tongue has not yet assigned any other name besides that of *madness* or *phrenzy*. Let us therefore now conjecture how it comes to pass that none of these great projectors do ever fail providing themselves and their notions with a number of *implicit disciples*; and I think the reason is easy to be assigned.—For there is a peculiar string in the harmony of human understanding, which, in several individuals, is exactly of the same tuning. This if you can dextrously *screw* up to its right key, and then *strike gently* upon it, whenever you have the good fortune to light among those of the *same pitch*, they will, by a secret necessary sympathy, strike exactly at the same time. And in this one circumstance lies all the *skill* or *luck* of the matter: For if you chance to jar the string, among those who are either above or below your own height, instead of subscribing to your doctrine, they will *tee you fast*, call you *mad*, and *feed* you with *bread and water*. It is therefore a point of the nicest conduct, to distinguish and adapt this noble talent with respect to the difference of *persons* and of *times*.—For, to speak a bold truth, it is a fatal miscarriage so ill to order affairs as to pass for a *fool* in one company, when in another you might be treated as a *philosopher*: Which I desire *some certain gentlemen of my acquaintance* to lay up in their hearts as a very *seasonable innuendo*."

We would not have dwelt so long upon this article, had it not been to guard, as far as our influence extends, the minds of those who may be unacquainted with the genuine principles of philosophy, from being led into a wrong track of investigation.

**ÆTHER**, in chymistry, a name given to any volatile spirit. The spirit which generally goes by that name is procured by distilling spirit of wine with oil of vitriol, and then precipitating with an alkali. See CHEMISTRY.

**ÆTHERIAL**, an epithet for any thing partaking of the nature of æther.

**ÆTHIOPIS**, in botany, a synonyme of a species of *salvia*. See SALVIA.

**ÆTHIOPS mineral**, a preparation of mercury made by rubbing equal quantities of quicksilver and flour of sulphur in a mortar, till the mercury wholly disappears, and a fine black powder remains.

**ÆTHIOPS albus**, a preparation of mercury made by rubbing



- robbing quicksilver with a double quantity of crabs-eyes or candied sugar, till it is extinguished.
- ETHIOPS** of *Dr Plumber*, a medicine prepared by levigating sulphur anatum antimoni with an equal quantity of calomel.
- ETHUSA**, in botany, a genus of the pentandria digynia class. The volucrum is dimidiated, triphylous, and pendulous. There is but one species, *viz.* the *æthusa synapium*, or fools-parsley, a native of Britain.
- ÆTIANS**, in church-history, a branch of Arians who maintained, that the Son and Holy Ghost are in all things dissimilar to the Father.
- ÆTIOLOGY**, that branch of physic which assigns the causes of diseases.
- ÆTITÆ**, or **ÆTITÆS**, a name given to pebbles or stones of any kind which have a loose nucleus rattling in them, called, in English, *Eagle-stones*.
- ÆTNA**, a famous burning mountain or volcano of Sicily. It is one of the highest mountains of the whole island, and situated on the eastern coast not far from Catania. It is remarked of this mountain, that its eruptions ceased immediately when those of Vesuvius began. See **VESUVIUS**.
- ÆTNA salt**, a name used by some authors for saline substances, found near the opening of mount Ætna and other volcanos.
- ÆTOLARCHA**, in Grecian antiquity, the principal magistrate or governor of the Ætolians.
- AFFA**, a weight used on the gold-coast of Guinea, and equal to an ounce.
- AFFECTIO bovina**, a disorder incident to cattle, occasioned by a small worm which eats its way all over the body.
- AFFECTION**, in a general sense, denotes an attribute inseparable from its subject, or an essential property of it. Thus, quantity, figure, weight, &c. are affections of all bodies.
- AFFECTIONS of the mind**. See **PASSIONS**, and **MORALS**.
- AFFEERERS**, or **AFFERORS**, in law, persons appointed in court-leets, courts-baron, &c. to settle, upon oath, the fines to be imposed upon those who have been guilty of faults arbitrarily punishable.
- AFFERI**, in law. See **AVERIA**.
- AFFETUOSO**, or *con AFFETTO*, in the Italian music, intimates, that the part to which it is added ought to be played in a tender moving way, and consequently rather slow than fast.
- AFFIANCE**, in law, denotes the mutual plighting of troth between a man and a woman to marry each other.
- AFFICHE**, a term used by the French for bills or advertisements hung or pasted up in public places to make any thing known.
- AFFIDATIO dominorum**, in old law-books, denotes an oath of allegiance taken by the lords in parliament.
- AFFIDATUS**, or **AFFIDIATUS**, in old law-books, signifies a tenant by fealty, or one who put himself under the protection of his lord, vowing fealty to him.
- AFFIDAVIT**, signifies an oath in writing, sworn before some person who is authorised to take the same.
- AFFILIATION**, a term used by some for adoption. See **ADOPTION**.
- AFFINAGE**, a term sometimes met with in old law-books, for the refining of metals.
- AFFINITY**, in Scots law, the connection formed by marriage betwixt one of the married persons and the blood-relations of the other. See **LAW**, title, **MARRIAGE**.
- AFFINITY**, is also used to denote conformity or agreement: Thus we say, the affinity of languages, the affinity of words, the affinity of sounds, &c.
- AFFINITY of bodies**. See **CHEMISTRY**, chapter, *Of elective attractions*.
- AFFIRMATION**, in logic, the asserting the truth of any proposition.
- AFFIRMATION**, is also used for the ratifying or confirming the sentence or decree of some inferior court: thus we say, the house of lords affirmed the decree of the lord-chancellor, or the decree of the lords of session.
- AFFIX**, among grammarians, denotes much the same with prefix. See **PREFIX**.
- AFFLATUS**, among heathen mythologists and poets, denotes the inspiration of some divinity.
- AFFORAGE**, in the French customs, a duty paid to the lord of a district, for permission to sell wine or other liquors within his seignory. It is also used for the rate or price of provisions fixed by the provost of Paris, or by the sheriffs.
- AFFORCEMENT**, among old law-writers, denotes a fortress or place of strength.
- AFFORCIAMENTUM curie**, a term used in old charterally for the summoning a court in an extraordinary manner.
- AFFORESTING**, in old law-books, is the turning lands into a forest; as the converting a forest to other uses is called *disafforesting*, or *deafforesting*.
- AFFRAY**, or **AFFRAYMENT**, in law, formerly signified the crime of affrighting other persons, by appearing in unusual armour, brandishing a weapon, &c. but at present, affray denotes a skirmish or fight between two or more.
- AFFREIGHTMENT**, a term used in some law-books for the freight of a ship.
- AFRI**, or **AFRA**, a term met with in old law-books for horses, bullocks, or any beast used in ploughing.
- AFFRONTÉE**, in heraldry, an appellation given to animals facing one another on an escutcheon, a kind of bearing, which is otherwise called *confrontée*, and stands opposed to *adversée*.
- AFFUIAGE**, in ancient customs, denotes the right or privilege of cutting wood in a forest for fuel.
- AFFILIATION**. See **AFFILIATION**.
- AFOBA**, in botany, an obsolete name of the phaseolus or kidney-bean. See **PHASEOLUS**.
- AFRA avir**, an obsolete name of the meleagris, or turkey. See **MELEAGRIS**.
- AFRA**, or **AFRUM**, in botany, a synonyme of a species of guaiacum. See **GUAIACUM**.
- AFRICA**, one of the four principal divisions of the earth;

earth; divided from Europe on the N. by the Mediterranean sea; from America on the W. by the Atlantic ocean; from the countries towards the south-pole, by the Great South-sea; from the island of Madagascar in the E. by the Mozambique channel; and from Asia also on the E. by the Red-sea. It is also joined to Asia by a narrow neck of land betwixt the Mediterranean and Red-sea, called *the isthmus of Suez*: Hence Africa is a peninsula somewhat resembling a pyramid, whose base from Tangier to the isthmus of Suez is about 2000 miles; its perpendicular, from the vertex at the cape of Good Hope to Buria, 3600 miles; and from cape Verd, to cape Guard a Fui, it is 3500. The situation of this quarter on the globe is betwixt 35. o. S. and 36. o. N. lat. and betwixt 17. 35. W. and 53. 21. E. long. Hence it lies, for the most part, within the tropics; by which means, in many places, the heat is almost insupportable. Along the coasts, it is in general reckoned abundantly fruitful, and its produce excellent. The Romans very justly considered Africa as the *patria ferarum*, for there is no other place breeds the number or the variety. In this quarter there are several deserts, some of them of vast extent, covered with sand, by which whole caravans have been sometimes smothered. The principal rivers are the Nile and the Niger, the first of which disembogues itself into the Mediterranean, after traversing Abyssinia, Nubia, and Egypt; and the last into the Atlantic ocean, by a western course from Upper Ethiopia. Geographers are not yet agreed about the sources of either of these rivers; according to some, their sources are not far distant from each other. There are some mountains in Africa remarkably high, particularly in Abyssinia and Barbary, in which last is the famous mount Atlas, which separates Barbary from Biledulgerid. The prevailing religions here, are Mahometanism and Paganism: Christianity only takes place among the Abyssinians and European settlements. The government in Africa is in general despotic, and the inhabitants black. In the division, geographers have gone variously to work; we shall confine ourselves to the more general, *viz.* EGYPT, BARBARY, GUINEY, CONGO, CAFFRARIA, ABYSSINIA, NUBIA, and NIGRITIA, with the islands that surround it; for which, see these articles.

**AFRICA**, is also a considerable sea-port town of Barbary, about seventy miles S. of Tunis.

**AFRICA**, *Afrique*, is likewise a small town of France, situated in the province of Gascony, and generality of Montauban.

**AFRICAN company**, a society of merchants, established by King Charles II. for trading to Africa; which trade is now laid open to all his majesty's subjects, paying 10 *per cent.* for maintaining the forts.

**AFSAGERS**, persons appointed by the burgo-masters of Amsterdam, to preside over the public sales made in that city.

**AFT**, in the sea-language, the same with *abaft*. See **ABAST**.

**AFTER-BIRTH**, in midwifery. See **MIDWIFERY**, and **SECUNDINES**.

**AFTER-MATH**, in husbandry, signifies the grass which springs or grows up after mowing.

**AFTER-PAINS**, in midwifery, pains in the groin, &c. after child-birth. See **MIDWIFERY**, title, *After-pains*.

**AFTER-SWARMS**, in the management of bees, are those which leave the hive some time after the first has swarmed. See **APIS**.

**AFTO**, in botany. See **ERYSIMUM**.

**AGA**, in the Turkish language, signifies a great lord or commander. Hence the Aga of the janissaries is the commander in chief of that corps; as the general of the horse is denominated *spahiclar aga*. See **JANISSARIES**, and **SPAHI**.

**AGADES**, or **AGDES**, a people or kingdom of Africa, lying on the northern bank of the river Niger, betwixt the kingdoms of Cano on the E. and Tombut on the W. with that of Zaara on the N.

**AGADES**, or **ANDEGAST**, the capital city of the said kingdom.

**AGADES**, is also the Moorish name for the town of Santa-Cruz, in the the kingdom of Sus.

**AGAG**, or **ARGAGA**, a kingdom of Africa, dependent on the kingdom of Monomotapa.

**AGAI**, in commerce. See **AGIO**.

**AGAI**, is also the name of a people of Ethiopia, inhabiting near the source of the Nile, and professing a kind of Christianity.

**AGALLOCHA**, in botany, the trivial name of the *exocaria*. See **EXOCARIA**.

**AGALMATA**, in antiquity, a term originally used for any kind of ornaments in a temple, but afterwards for the statues only.

**AGANIPPIDES**, in ancient poetry, a designation given to the muses, from a fountain of mount Helicon called *Aganippe*.

**AGAPÆ**, or **AGAPES**, in church-history, certain love-feasts kept by the ancient Christians, as a token of brotherly charity and mutual benevolence.

However innocent the original intention of these festivals might have been, abuses in time got footing in them, and gave great occasion to scandal; so that it became necessary to forbid the kiss of charity between different sexes, as well as to have any beds or couches in the place where they assembled.

**AGAPETÆ**, in church-history, a kind of nuns among the primitive Christians, who attended on and served the clergy.

At first there was nothing scandalous in those societies, though they gave great offence afterwards, and were wholly abolished by the council of Lateran, in 1139.

**AGARENI**, a name used by some writers for the Arabs, as being descended from Agar, or Hagar, Abraham's hand-maid.

**AGARICO-fungus**, in botany, a synonyme of the *agaricus alneus*, or alder-agaric.

**AGARICO-pylorus**, a synonyme of the *boletus versicolor*. See **BOLETUS**.

**AGARICUS**, in botany, a genus of the cryptogamia fungi. Of this genus there are 28 species, 24 of which are

are natives of Britain. Several species of the agaric grow upon the trunks of the larch, the oak, and other trees. It is of a spongy substance, resembling the mushroom, and irregular in its figure and size. This plant has of late been tried for stopping hæmorrhages after amputations: but the success has not been so remarkable as to bring it into general use.

*Mineral* AGARIC, a marley earth resembling the vegetable of that name in colour and texture. It is found in the fissures of rocks, and on the roofs of caverns; and is sometimes used as an astringent in fluxes, hæmorrhages, &c.

AGASYLLIS, a name used by the Greeks for ammoniac. See AMMONIAC.

AGAT, is a stone resembling the onyx in colour, but, in place of zones, is adorned with lines or spots of various colours, which run into so many figures, as to resemble trees, flowers, fruits, herbs, &c. Of the agat there are several species, distinguished from each other chiefly by their colour; as, the white-veined agat, the lead-coloured agat, the flesh-coloured agat, &c.

AGAT, is also the name of an instrument used by gold-wire-drawers, so called from the agat in the middle of it, which forms its principal part.

AGATA, or *St AGATA di Gotti*, a city and bishop's see of Naples, and province of Principato, situated almost in the middle between Capua and Beneventum.

AGATONSI, a small island of the Archipelago, situated between that of Lesbos and the continent.

AGATTON, a town of Africa, on the coast of Guiney, situated near the mouth of the river Formosa, about eighty miles south of Benin.

AGATY, in botany, a synonyme of the æschynomene. See ÆSCHYNOSE.

AGAVE, in botany, a genus of the hexandria monogynia class. Under this genus Linnæus ranks 4 species of the Aloes, *viz.* the america, vivipara, virginica, and fœtida. See ALOE.

AGAZES, a name given to the inhabitants of Paraguay in S. America.

AGDE, a small but well inhabited city of France, in the province of Languedoc, near the mouth of the river Eraut, about thirty miles S. W. of Montpellier. It is the see of a bishop.

AGE, a certain portion or part of duration applied to the existence of particular objects: thus we say, the age of the world, the age of Rome, &c. that is, the time or number of years elapsed since the creation of the world, or the building of Rome. See ASTRONOMY, *Of the division of time.*

The ancient poets also divided the duration of the world into four ages or periods; the first of which they called the *golden age*, the second the *silver age*, the third the *braxen age*, and the fourth the *iron age*.

AGE, in law, signifies a certain period of life, when persons of both sexes are enabled to do certain acts: thus, a man at twelve years of age ought to take the oath of allegiance to the king in a leet; at fourteen he may marry, chuse his guardian, and claim his lands held in socage.

Twenty-one is called full age, a man or woman being then capable of acting for themselves, of managing their affairs, making contracts, disposing of their estates, and the like.

AGE-PRIER, *etatem precari*, in law, is when an action being brought against a person under age, for lands descended to him, he, by motion or petition, shews the matter to the court, praying the action may be staid till his full age; which the court generally agrees to.

AGE of the moon, in astronomy, the time elapsed since her last conjunction with the sun. See ASTRONOMY.

AGEDA, in geography, a small town and river of Portugal, situated in the province of Beiran, between the cities of Oporto and Coimbra.

AGEMA, in Macedonian antiquity, was a body of soldiery, not unlike the Roman legion. See LEGION.

AGEMOGLANS, or AGIAMOGLANS, or AZAMOGLANS, in the Turkish customs, Christian children raised every third year, by way of tribute, from the Christians tolerated in the Turkish empire.

AGEN, an ancient city of France, in the province of Guienne, situated on the river Garonne, about sixty miles S. E. of Bourdeaux. It is a bishop's see, and the capital of the Agenois.

AGENDA, among philosophers and divines, signifies the duties which a man lies under an obligation to perform: thus, we meet with the agenda of a Christian, or the duties he ought to perform, in opposition to the credenda, or things he is to believe.

AGENDA, among merchants, a term sometimes used for a memorandum-book, in which is set down all the business to be transacted during the day, either at home or abroad.

AGENHINE, the same with hogenhine. See HOGENWINE.

AGENOIS. See AGEN.

AGENORIA, in mythology, the goddess of courage and industry, as Vacuna was of indolence.

AGENT, in a general sense, denotes any active power or cause. Agents are either natural or moral. Natural agents are such inanimate bodies as have a power to act upon other bodies in a certain and determinate manner, as gravity, fire, &c. Moral agents, on the contrary, are rational creatures, capable of regulating their actions by a certain rule.

AGENT, is also used to denote a person intrusted with the management of an affair, whether belonging to a society, company, or private person.

AGENTS of bank and exchange, in the commercial polity of France, are much the same with our exchange-brokers.

AGENT and patient, in law, is said of a person who is the doer of a thing, and also the party to whom it is done.

AGENTS in rebus, in antiquity, signifies officers employed under the emperors of Constantinople, and differing only in name from the frumentarii, whom they succeeded. See FRUMENTARIII.

AGER, in Roman antiquity, a certain portion of land allowed to each citizen. See AGRARIAN LAW.

- AGER**, is also used by middle-age writers, for an acre of land. See **ACRE**.
- AGER mineralium**, among chemists, signifies the element of water, as water is supposed to be the origin of minerals.
- AGER natura**, a name sometimes applied to the uterus, as it nourishes the semen in the same manner as the earth nourishes seeds.
- AGER**, in geography, a small town of Catalonia in Spain, situated near the source of the river Noguera.
- AGERATUM**, or **MAUDLIN**, in botany, a genus of the syngenesia polygamia æqualis class. The receptacle is naked; the pappus has five aristæ or auns; the calix is oblong; and the stylus a little longer than the flower. There are three species of the ageratum, *viz.* the conyzoides, the ciliare, and the altissimum, all natives of America.
- AGERATUS lapis**, a stone used by the ancients in dying and dressing leather.
- AGERIUM**. See **AGISTMENT**.
- AGGA**, or **AGONNA**, a British settlement on the gold-coast of Guiney. It is situated under the meridian of London, in 6 degrees of N. lat.
- AGGER**, in the ancient military art, a bank or rampart, composed of various materials, as earth, boughs of trees, &c.
- The agger of the ancients was of the same nature with what the moderns call *lines*.
- AGGERHUYS**, a city of Norway, capital of the province of the same name. It is subject to Denmark, and situated in 28. 35. E. long. and 59. 30. N. lat.
- AGGIA-SARAI**, a town situated on the shore of the Caspian sea, between Turkestan and the country of Bulgar.
- AGGLUTINANTS**, in pharmacy, medicines of a glutinous or viscid nature, given with a view to strengthen the solids.
- AGGLUTINANTS**, among surgeons. See **VULNERARIES**.
- AGGLUTINATION**, in a general sense, denotes the joining two or more things together, by means of a proper glue or cement.
- AGGLUTINATION**, among physicians, the adherence of new substance, or the giving a glutinous quality to the animal fluids.
- AGGLUTINATION**, is also a term used by astronomers to denote the meeting of two or more stars in the same part of the zodiac, or the seeming coalition of several stars.
- AGGRAVATION**, a term used to denote whatever heightens a crime, or renders it more black.
- AGGREGATE**, in a general sense, denotes the sum of several things added together, or the collection of them into one whole. Thus, a house is an aggregate of stones, wood, mortar, &c. It differs from a mixed or compound, inasmuch as the union in these last is more intimate than between the parts of an aggregate. See **CHEMISTRY**, *Of mixts*.
- AGGRESSOR**, among lawyers, denotes the person who began a quarrel, or made the first assault.
- AGHER**, **ACHER**, or **AUGHER**, a town of Ireland, which sends two members to parliament. It is situated in the southern part of Ulster, not far from Clogher.
- AGHRIM**, a town of Ireland, in the county of Wicklow, and province of Leinster, situated about thirteen miles south-west of Wicklow.
- AGIADES**, in the Turkish armies, a kind of pioneers employed in fortifying camps, and the like offices.
- AGIASMA**. See **HAGIASMA**.
- AGIGENSALON**, a town of Turkey, upon the road from Constantinople to Ispahan, about a day's journey from the city of Tocia.
- AGILD**, or **AGILDE**, in old law-books, denotes a person of so little account, that whoever killed him was liable to no fine or other punishment.
- AGILITY**, an aptitude of the several parts of the body to motion; or it may be defined, the art or talent of making the best use of our strength.
- AGILLARIUS**, in old law-books. See **HAYWARD**.
- AGINCOURT**, a village of the French Netherlands; famous on account of the victory obtained by Henry V. of England over the French, in 1415.
- AGIO**, in commerce, a term chiefly used in Holland and at Venice, where it denotes the difference between the value of bank-stock and the current coin.
- AGIO of assurance**, the same with what we call *policy of assurance*. See **POLICY of assurance**.
- AGIST**. See the next article.
- AGISTMENT**, **AGISTAGE**, or **AGISTATION**, in law, the taking in other people's cattle to graze at so much *per week*. It is also used in a metaphorical sense, for any tax, burthen, or charge; thus, the tax levied for repairing the banks of Romney marsh was called *agistamentum*.
- AGISTOR**, or **AGISTATOR**, an officer belonging to forests, who has the care of cattle taken in to be grazed, and levies the moneys due on that account.
- AGISTALIA animalium in foresta**, in old law-books, signifies the drift of cattle or beasts in a forest.
- AGITATION**, the act of shaking a body, or tossing it backwards and forwards.
- AGITATOR**, in antiquity, a term sometimes used for a charioteer, especially those who drove in the circus at the cürule games.
- AGITATORS**, in the English history, certain officers set up by the army, in 1647, to take care of its interests.
- Cromwell joined the agitators, only with a view to serve his own ends; which being once accomplished, he found means to get them abolished.
- AGLA**, or **AQUILA**, a town of Africa in the kingdom of Fez, situated not far from the river Guarga.
- AGLAOPHOTIS**, in botany, an obsolete name of the pæonia. See **PÆONIA**.
- AGLECTS**, **AGLETS**, or **AGLEBDS**, in botany. See **ANTHERÆ**.
- AGLIA**, in geography, a fortress of Piedmont, with the title of marquise, situated in the Canavois.
- AGMOT**, or **AGMET**, the name of a town, district, and river of Africa, in the empire of Morocco.
- AGMEN**, in the Roman art of war, denoted an army,

- or rather a part of it, in march : Thus we read of the *primum agmen*, or van-guard ; *medium agmen*, or main body ; and the *postremum agmen*, or rear-guard.
- AGMONDESHAM**, in geography. See **AMERSHAM**.
- AGNABAT**, a town of Transylvania, subject to the house of Austria, situated about ten miles north-east of Hermanstadt.
- AGNANO**, a lake of the kingdom of Naples, in the province of Lavoro.
- AGNANTHUS**, in botany, a synonyme of the cornutia. See **CORNUTIA**.
- AGNATE**, in Scots law, any male relation by the father's side. See **LAW**, title, *Minors, and their tutors and curators*.
- AGNEL**, an ancient French coin, otherwise called *mouton d'or*. See **MOUTON D'OR**.
- AGNELET**, an ancient French coin, worth about twenty sols.
- AGNO**, a river of Naples, which, taking its rise in the mountainous parts of Terra di Lavoro, washes the town of Acerra, and, passing between Capua and Aversa, falls into the Mediterranean, about seven miles N. of Puzzoli.
- AGNOETÆ**, in church-history, a sect of heretics, so called on account of their maintaining, that Christ, with respect to his human nature, was ignorant of many things, and particularly of the day of judgment, an opinion which they built upon the text, Mark xiii. 32.
- AGNOMEN**, in Roman antiquity, a kind of fourth or honorary name, given to a person on account of some extraordinary action, virtue, or other accomplishment. Thus, the agnomen *Africanus* was bestowed upon Publius Cornelius Scipio, on account of his great achievements in Africa.
- AGNON**, a small river of Bourgogne in France, otherwise called *Ignon*.
- AGNONE**, a city of the kingdom of Naples, in the province of the Hither Abruzzo, called by some *Anclone*.
- AGNOS**, in ichthyology, an obsolete name of the uranoscopus. See **URANOSCOPIUS**.
- AGNUS**, or **LAMB**, in zoology, the young of the ovine or sheep. See **OVIS**.
- AGNUS castus**, in botany, the trivial name of a species of the vitex. See **VITEX**.
- AGNUS Dei**, in the church of Rome, a cake of wax stamped with the figure of a lamb supporting a cross. These being consecrated by the pope with great solemnity, and distributed among the people, are supposed to have great virtues ; as, to preserve those who carry them worthily, and with faith, from all manner of accidents ; to expel evil spirits, &c. It is also a popular name for that part of the mass, where the priest strikes his breast thrice, and says the prayer beginning with the words *Agnus Dei*.
- AGNUS Scythicus**, in botany, the name of a fictitious plant said to grow in Tartary, resembling a lamb.
- AGOBEL**, a small town of Africa, in the empire of Morocco, and province of Hea.
- AGOGA**, among ancient naturalists, denoted a drain for carrying off water from a mine.
- AGOGE**, among ancient musicians, a species of modulation, wherein the notes proceeded by contiguous degrees.
- AGON**, in the public games of the ancients, a term used indifferently for any contest or dispute, whether respecting bodily exercises, or accomplishments of the mind. Thus poets, musicians, &c. had their agones, as well as the athletes. It was also used for one of the ministers employed in the heathen sacrifices, whose business it was to strike the victim.
- AGON**, in Roman antiquity, a place near the Tiber, where the curule games were celebrated, otherwise called *circus Flammineus*.
- AGON**, among physicians. See **AGONY**.
- AGONALIS**, in Roman antiquity. See **SALII**.
- AGONALIA**, in Roman antiquity, festivals celebrated in honour of Janus, or of the god Agonius, whom the Romans invoked before undertaking any affair of importance.
- AGONENSES**. See **SALII**.
- AGONISMA**, in antiquity, denotes the prize given to the victor in any combat or dispute.
- AGONISTARCHA**, in antiquity, the officer who directed the preparatory exercises of the athletes ; tho' some make him the same with the agonotheta. See **AGONOTHETA**.
- AGONISTICA**, a term used to denote the science of whatever belonged to the agones, or public exercises of the ancients.
- AGONISTICI**, in church-history, a name given by Donatus to such of his disciples as he sent to fairs, markets, and other public places, to propagate his doctrine.
- AGONISTICON**, a term used by physicians for cold water, as being supposed to combat the febrile heat.
- AGONIUM**, in Roman antiquity, was used for the day on which the *rex sacrorum* sacrificed a victim, as well as for the place where the games were celebrated, otherwise called *Agon*.
- AGONOTHETA**, or **AGONOTHETES**, in Grecian antiquity, was the president or superintendent of the sacred games ; who not only defrayed the expences attending them, but inspected the manners and discipline of the athletes, and adjudged the prizes to the victors.
- AGONUS**, in ichthyology, a synonyme of the clupea alosa. See **CLUPEA**.
- AGONY**, any extreme pain. It is also used for the pangs of death.
- AGONYCLITÆ**, or **AGONYCLITES**, in church-history, a sect of christians, in the seventh century, who prayed always standing, as thinking it unlawful to kneel.
- AGORÆUS**, in heathen antiquity, an appellation given to such deities as had statues in the market-places ; particularly Mercury, whose statue was to be seen in almost every public place.
- AGORANOMUS**, in Grecian antiquity, a magistrate of Athens, who had the regulation of weights and measures, of the prices of provisions, &c.
- AGOUGES**,

**AGOUGES**, a river of France, which, after watering part of Auvergne, falls into the Sioule.

**AGRA**, a city of the Hither India, and capital of a kingdom of the same name. It is situated on the river Jemma, and is a large, populous, and beautiful city, where the Mogul frequently resides.

**AGRAM**, a city and bishop's see of Hungary, situated near the frontiers of Carniola.

**AGRARIAN laws**, among the Romans, those relating to the division and distribution of lands; of which there were a great number; but that called the *Agrarian law*, by way of eminence, was published by Spurius Cassius, about the year of Rome 268, for dividing the conquered lands equally among all the citizens, and limiting the number of acres which each citizen might enjoy.

**AGRARIUM**. See **AGISTMENT**.

**AGREDA**, a town of Spain, in old Castile, near the frontiers of Arragon, and about three leagues south-west of Taracon.

**AGREDA**, is also a town of South America, situated at the foot of the mountains in the kingdom of Popaian.

**AGREEMENT**, in law, signifies the consent of several persons to any thing done or to be done.

**AGRESSES**, or **OGRESSES**, in heraldry, a term sometimes used for pellets. See **PELLETS**.

**AGRESTÆ**, among physicians, denotes unripe grapes, said to be of a cooling nature.

**AGRI**, or **ACRI**, a river of the kingdom of Naples, which arising in the Apennine mountains, not far from Marico Nuovo, falls into the gulph of Tarento.

**AGRIA**, a town and river of Upper Hungary. The town is a bishop's see, and situated about thirty-five miles N. E. of Buda.

## A G R I C U L T U R E.

**A**GRICULTURE is the art of assisting the earth, by means of culture, manure, &c. to bring forth plants in greater quantity, and likewise of a larger size and better quality, than it would produce without these assistances.

**A**GRICULTURE is an art of such consequence to mankind, that their very existence, especially in a state of society, depends upon it. A compendious view, therefore, of every material discovery that hath hitherto

been made in this art, must be useful both to the farmer and philosopher.

To accomplish this end with the greater perspicuity, the subject shall be divided into two parts. Under the first, *Vegetation*, and the *Structure of Plants*, shall be considered. The second will contain the various *Operations upon the Soil*, in order to prepare it for the reception and nourishment of plants.

For the ease of the reader, each of these parts shall be subdivided into a number of sections.

### P A R T I.

#### *Of Vegetation, and the Structure of Plants.*

**T**HE vegetation and œconomy of plants is one of those subjects in which our knowledge is extremely circumscribed. Many hypotheses have been invented; as many have been, or may easily be, refuted. Hypotheses in matters that evidently exceed our powers do much hurt: But they are likewise of some use. They incite to further inquiries; and these inquiries are carried on with greater spirit, because they are intended for the purpose of confuting. It is true this spirit is not the most friendly to impartial observation; but it makes us more indefatigable in our researches.

Retailing theories is no part of our plan. A total inattention to the structure and œconomy of plants is the chief reason of the small progress that has been made in the principles of vegetation, and of the instability and fluctuation of our theories concerning it.

To recall the attention of philosophers and cultivators, to the only source from which any solid theory can ever be formed on this subject, we shall give a short descrip-

tion of the structure of plants, beginning with the seed, and tracing its progress and evolution to a state of maturity.

#### SECT. I. *Of Seeds.*

**T**HE seeds of plants are of various figures and sizes. Most of them are divided into two lobes; though some, as those of the cress-kind, have six; and others, as the grains of corn, are not divided, but intire.

But, as the essential properties of all seeds are the same, when considered with regard to the principles of vegetation, our particular descriptions shall be limited to one seed, *viz.* the great garden-bean. Neither is the choice of this seed altogether arbitrary; for, after it begins to vegetate, its parts are more conspicuous than many others, and consequently better calculated for investigation.

This seed is covered with two coats or membranes. The



Plate IV.

Fig. 1. GARDEN BEAN

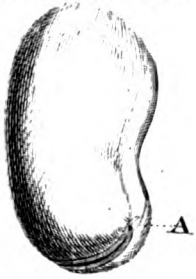


Fig. 2.



Fig. 3.

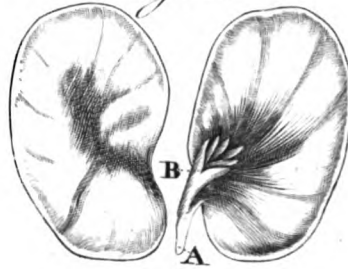


Fig. 4. Slice of a BEAN

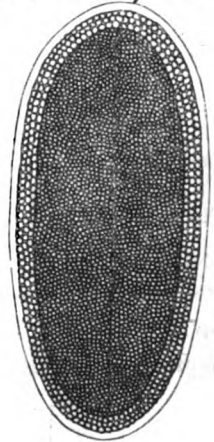


Fig. 5. Radical



Fig. 6. Plume



Fig. 7.

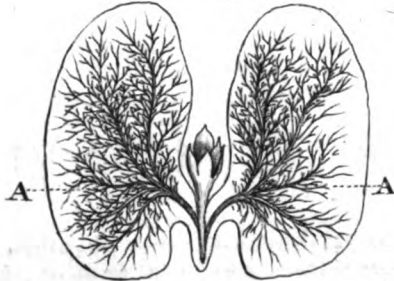


Fig. 8.

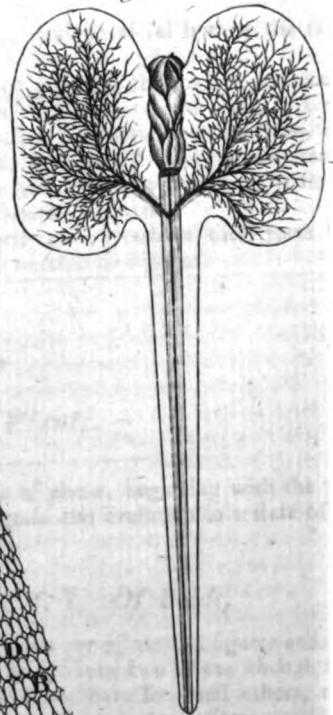


Fig. 10. Section of Fig. 9. Magnified

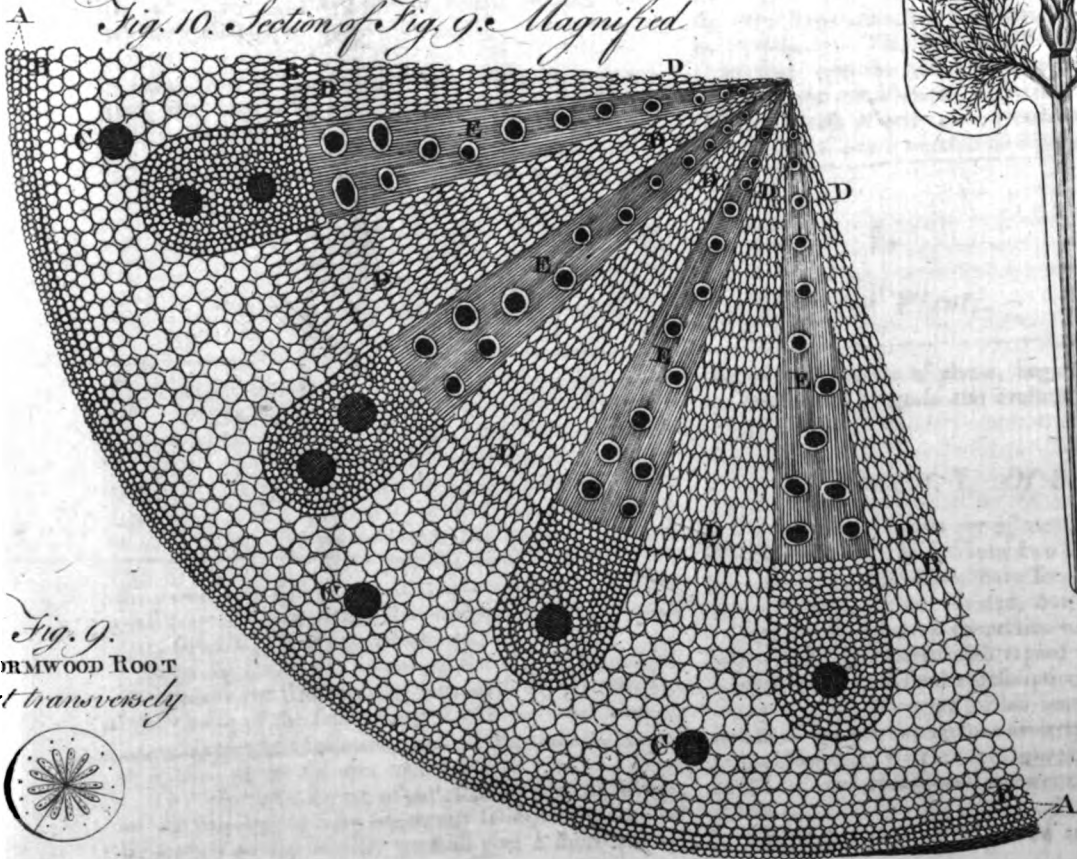
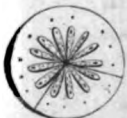


Fig. 9. WORMWOOD ROOT cut transversely



Abell Sculp



The outer coat is extremely thin, and full of pores; but may be easily separated from the inner one, (which is much thicker), after the bean has been boiled, or lain a few days in the soil. At the thick end of the bean, there is a small hole visible to the naked eye, immediately over the radicle or future root, that it may have a free passage into the soil. Plate IV. fig. 1. A. When these coats are taken off, the body of the seed appears, which is divided into two smooth portions or lobes. The smoothness of the lobes is owing to a thin film or cuticle with which they are covered.

At the basis of the bean is placed the radicle or future root, Plate IV. fig. 3. A. The trunk of the radicle, just as it enters into the body of the seed, divides into two capital branches, one of which is inserted into each lobe, and sends off smaller ones in all directions through the whole substance of the lobes, Plate IV. fig. 7. A. A. These ramifications become so extremely minute towards the edges of the lobes, that they require the finest glasses to render them visible. To these ramifications Grew and Malpighius have given the name of *feminal root*; because, by means of it, the radicle and plume, before they are expanded, derive their principal nourishment.

The plume, bud, or germ, Plate IV. fig. 3. is inclosed in two small corresponding cavities in each lobe. Its colour and consistence is much the same with those of the radicle, of which it is only a continuation; but having a quite contrary direction: For the radicle descends into the earth, and divides into a great number of smaller branches or filaments; but the plume ascends into the open air, and unfolds itself into all the beautiful variety of stem, branches, leaves, flowers, fruit, &c. The plume in corn shoots from the smaller end of the grain, and, among maltsters, goes by the name of *acrospire*.

The next thing to be taken notice of is the substance, or parenchymatous part of the lobes. This is not a mere concentered juice, but is curiously organised, and consists of a vast number of small bladders resembling those in the pith of trees, Plate IV. fig. 4.

Besides the coats, cuticle, and parenchymatous parts, there is a substance perfectly distinct from these, distributed in different proportions through the radicle, plume, and lobes. This inner substance appears very plainly in a transverse section of the radicle or plume. Towards the extremity of the radicle, it is one entire trunk; but higher up, it divides into three branches; the middle one runs directly up to the plume, and the other two pass into the lobes on each side, and spread out into a great variety of small branches through the whole body of the lobes, Plate IV. fig. 7. This substance is very properly termed the *feminal root*: for when the seed is sown, the moisture is first absorbed by the outer coats, which are every where furnished with sap and air-vessels; from these it is conveyed to the cuticle; from the cuticle it proceeds to the pulpy part of the lobes; when it has got thus far, it is taken up by the mouths of the small branches of the feminal root, and passes from one branch into another, till it is all collected into the main trunk, which communicates both with the plume and radicle, the two principal involved organs of the future plant. After this the sap, or vegetable food, runs in two oppo-

site directions; part of it ascends into the plume, and promotes the growth and expansion of that organ; and part of it descends into the radicle, for nourishing and evolving the root and its various filaments. Thus the plume and radicle continue their progress in opposite directions, till the plant arrives at maturity.

It is here worth remarking, that every plant is really possessed of two roots, both of which are contained in the seed. The plume and radicle, when the seed is first deposited in the earth, derive their nourishment from the feminal root: but, afterwards, when the radicle begins to shoot out its filaments, and to absorb some moisture, not, however, in a sufficient quantity to supply the exigencies of the plume, the two lobes, or main body of the seed, rise along with the plume, assume the appearance of two leaves, resembling the lobes of the seed in size and shape, but having no resemblance to those of the plume, for which reason they have got the name of *dissimilar leaves*.

These dissimilar leaves defend the young plume from the injuries of the weather, and at the same time, by absorbing dew, air, &c. assist the tender radicle in nourishing the plume, with which they have still a connection by means of the feminal root above described. But, when the radicle or second root has descended deep enough into the earth, and has acquired a sufficient number of filaments or branches for absorbing as much aliment as is proper for the growth of the plume; then the feminal, or dissimilar leaves, their utility being entirely superseded, begin to decay and fall off.

- PLATE IV. Fig. 1. A, The foramen, or hole in the bean through which the radicle shoots into the soil.  
 Fig. 2. A transverse section of the bean; the dots being the branches of the feminal root.  
 Fig. 3. A, The radicle.  
 B, The plume or bud.  
 Fig. 4. A, A longitudinal section of one of the lobes of the bean a little magnified, to show the small bladders of which the pulpy or parenchymatous part is composed.  
 Fig. 5, 6. A, A transverse section of the radicle.  
 B, A transverse section of the plume, showing the organs or vessels of the feminal root.  
 Fig. 7. A, A view of the feminal root branched out upon the lobes.  
 Fig. 8. The appearance of the radicle, plume, and feminal root, when a little further advanced in growth.

Having thus briefly described the seed, and traced its evolution into three principal organic parts, *viz.* the plume, radicle, and feminal leaves, we shall next take an anatomical view of the root, trunk, leaves, &c.

S E C T. II. *Of the Root.*

IN examining the root of plants, the first thing that presents itself is the skin, which is of various colours in different plants. Every root, after it has arrived at a certain age, has a double skin. The first is coeval with the other parts, and exists in the seed: but afterwards there is a ring sent off from the bark, and forms a second skin; *e. g.* in the root of the dandelion, towards the end of May, the original or outer skin appears shriveled, and is easily separated from the new one, which is fresher, and adheres more firmly to the bark. Perennial plants are supplied in this manner with a new skin every year; the outer one always falls off in the autumn or winter, and a new one is formed from the bark in the succeeding spring. The skin has numerous cells or vessels, and is a continuation of the parenchymatous part of the radicle. However, it does not consist solely of parenchyma; for the microscope shews that there are many tubular lignous vessels interspersed through it.

When the skin is removed, the true cortical substance or bark appears, which is also a continuation of the parenchymatous part of the radicle, but greatly augmented. The bark is of very different sizes. In most trees, it is exceeding thin in proportion to the wood and pith. On the other hand, in carrots, it is almost one half of the semidiameter of the root; and, in dandelion, it is nearly twice as thick as the woody part.

1. The BARK is composed of two substances; the parenchyma, or pulp, which is the principal part; and a few woody fibres. The parenchyma is exceedingly porous, and has a great resemblance to a sponge; for it shrivels considerably when dried, and dilates to its former dimensions when infused in water. These pores or vessels are not pervious so as to communicate with each other, but consist of distinct little cells or bladders, scarcely visible without the assistance of the microscope. In all roots, these cells are constantly filled with a thin watery liquor. They are generally of a spherical figure; though in some roots, as the bugloss and dandelion, they are oblong. In many roots, as the horse-raddish, peony, asparagus, potatoe, &c. the parenchyma is of one uniform structure. But in others it is more diversified, and puts on the shape of rays running from the centre towards the circumference of the bark. These rays sometimes run quite through the bark, as in lovage; and sometimes advance towards the middle of it, as in melilot and most of the leguminous and umbelliferous plants. These rays generally stand at an equal distance from each other in the same plant; but the distance varies greatly in different plants. Neither are they of equal sizes: In carrot they are exceedingly small, and scarcely discernible; in melilot and chervil, they are thicker. They are likewise more numerous in some plants than in others. Sometimes they are of the same thickness from one edge of the bark to the other; and some grow wider as they approach towards the skin. The vessels with which these rays are amply furnished, are supposed to be air-vessels, because they are always found to be dry, and not so transparent as the vessels which evidently contain the sap.

In all roots, there are lignous vessels dispersed in different proportions through the parenchyma of the bark. These lignous vessels run longitudinally through the bark in the form of small threads, which are tubular, as is evident from the rising of the sap in them when a root is cut transversely. These lignous sap-vessels do not run in direct lines through the bark, but, at small distances, incline towards one another in such a manner, that they appear to the naked eye to be inosculed; but the microscope discovers them to be only contiguous, and braced together by the parenchyma. These braces or coarctations are very various both in size and number in different roots; but in all plants they are most numerous towards the inner edge of the bark. Neither are these vessels single tubes, but, like the nerves in animals, are bundles of twenty or thirty small contiguous cylindrical tubes, which uniformly run from the extremity of the root, without sending off any branches, or suffering any change in their size or shape.

In some roots, as parsnip, especially in the ring next the inner extremity of the bark, these vessels contain a kind of lymph, which is sweeter than the sap contained in the bladders of the parenchyma. From this circumstance they have got the name of *lymph-ducts*.

These lymph-ducts sometimes yield a mucilaginous lymph, as in the comphrey; and sometimes a white milky glutinous lymph, as in the angelica, sonchus, burdock, scorzonera, dandelion, &c. The lymph-ducts are supposed to be the vessels from which the gums and balsams are secreted. The lymph of fennil, when exposed to the air, turns into a clear transparent balsam; and that of the scorzonera, dandelion, &c. condenses into a gum.

The situation of the vessels is various. In some plants, they stand in a ring or circle at the inner edge of the bark, as in asparagus; in others, they appear in lines, or rays, as in borage; in the parsnip, and several other plants, they are most conspicuous toward the outer edge of the bark; and in the dandelion, they are disposed in the form of concentric circles.

2. The WOOD of roots is that part which appears after the bark is taken off, and is firmer and less porous than the bark or pith. It consists of two distinct substances, *viz.* the pulpy, or parenchymatous, and the lignous. The wood is connected to the bark by large portions of the bark inserted into it. These insertions are mostly in the form of rays, tending to the centre of the pith, which are easily discernible by the eye in a transverse section of most roots. These insertions, like the bark, consist of many vessels, mostly of a round or oval figure.

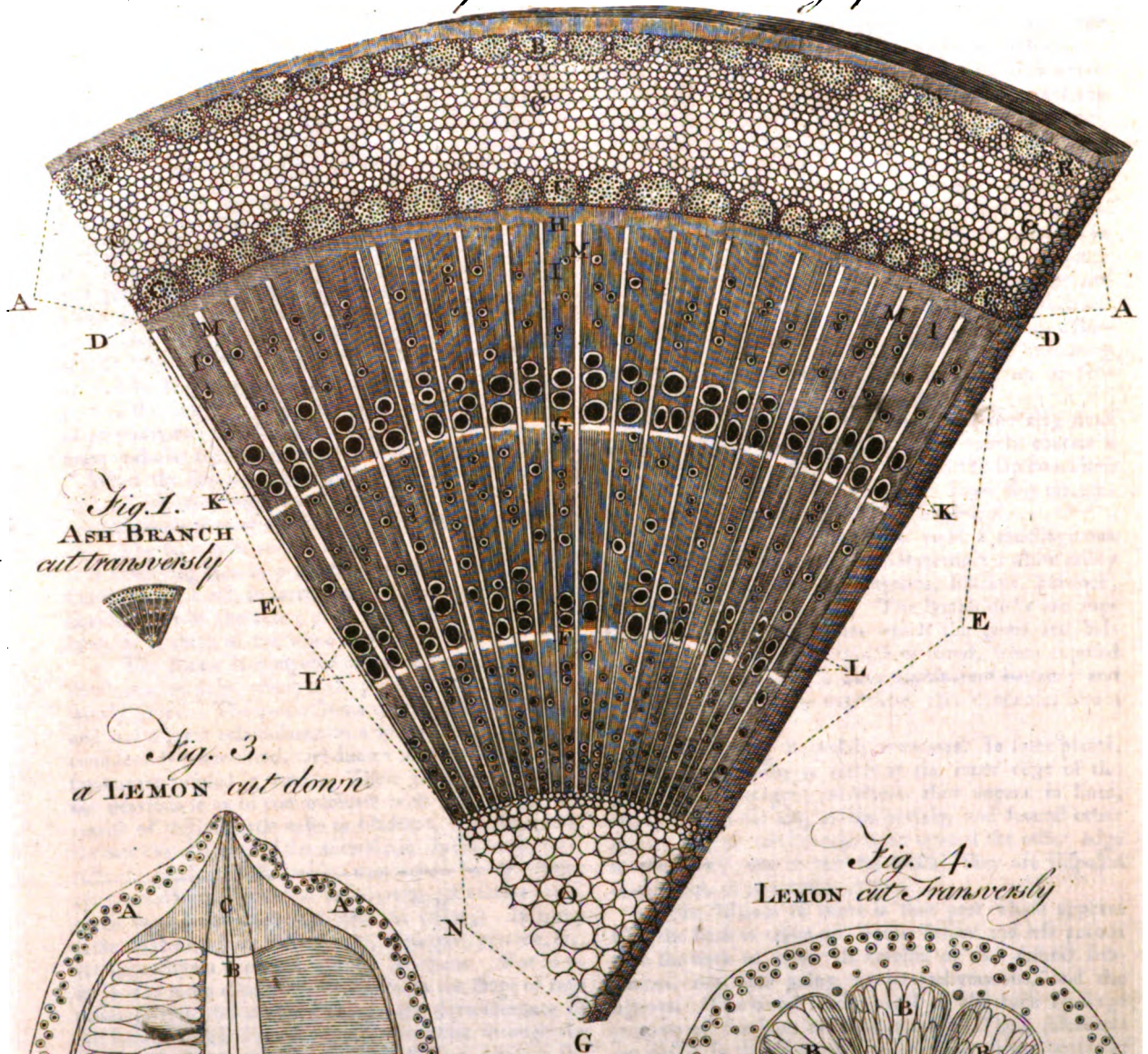
The lignous vessels are generally disposed in collateral rows running longitudinally through the root. Some of these contain air, and others sap. The air-vessels are so called, because they contain no liquor. These air-vessels are distinguished by being whiter than the others.

3. The PITH is the central part of the root. Some roots have no pith, as the stramonium, nicotiana, &c. others have little or none at the extremities of the roots, but have a considerable quantity of it near the top. The pith, like every other part of a plant, is derived from



Plate V.

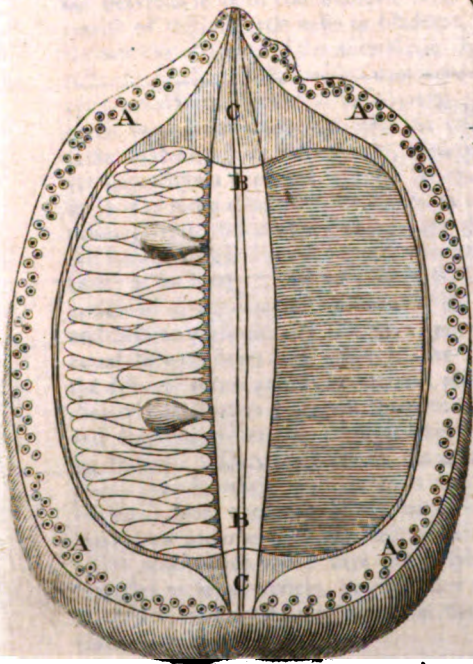
*Fig. 2.*  
*Transverse section of the ASH BRANCH. Magnified.*



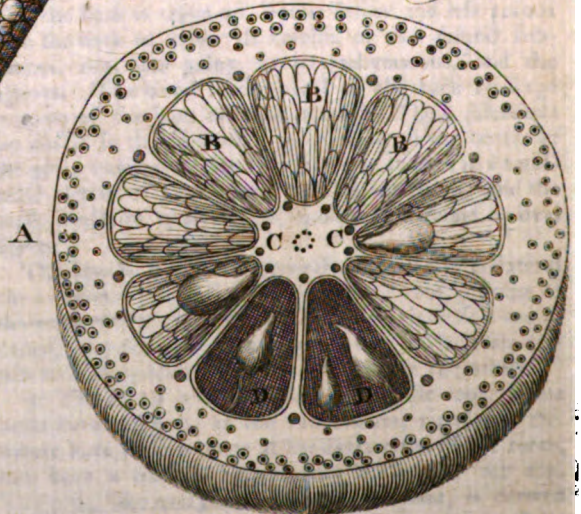
*Fig. 1.* K  
ASH BRANCH  
cut transversly



*Fig. 3.*  
a LEMON cut down



*Fig. 4.*  
LEMON cut transversly



*A. Bell. Sculp.*

from the seed: But in some it is more immediately derived from the bark. For the insertions of the bark running in betwixt the rays of the wood, meet in the centre, and constitute the pith. It is owing to this circumstance, that among roots which have no pith in their lower parts, they are amply provided with it towards the top, as in columbine, lovage, &c.

The bladders of the pith are of very different sizes, and generally of a circular figure. Their position is more uniform than in the bark. Their sides are not mere films, but a composition of small fibres or threads; which gives the pith, when viewed with a microscope, the appearance of a piece of fine gauze, or net-work.

We shall conclude the description of roots, with observing, that their whole substance is nothing but a congeries of tubes and fibres, adapted by nature for the absorption of nourishment, and of course the extension and augmentation of their parts.

PLATE IV. *Fig. 9.* A transverse section of the root of wormwood, as it appears to the naked eye.

- Fig. 10.* A section of *fig. 9.* magnified.  
 A A, The skin, with its vessels.  
 B B B B, The bark. The round holes, C C C, &c. are the lymph-ducts of the bark. All the other holes are little cells and sap-vessels.  
 D D D, Parenchymatous insertions from the bark, with the cells, &c.  
 E E E E, The rays of the wood, in which the holes are the air-vessels.

*N. B.* This root has no pith.

SECT. III. *Of the Trunk, Stalk, or Stem.*

In describing the trunks of plants, it is necessary to premise, that whatever is said with regard to them, applies equally to the branches,

The trunk, like the root, consists of three parts, *viz.* the bark, wood, and pith. These parts, though substantially the same in the trunk as in the root, are in many cases very different in their texture and appearance.

1. The skin of the bark is composed of very minute bladders, interspersed with longitudinal woody fibres, as in the nettle, thistle, and most herbs. The outside of the skin is visibly porous in some plants, particularly the cane.

The principal body of the bark is composed of pulp or parenchyma, and innumerable vessels much larger than those of the skin. The texture of the pulpy part, tho' the same substance with the parenchyma in roots, yet seldom appears in the form of rays running towards the pith; and when these rays do appear, they do not extend above half way to the circumference. The vessels of the bark are very differently situated, and destined for various purposes in different plants. For example, in the bark of the Pine, the inmost are lymph-ducts, and exceedingly small; the outmost are gum or resiniferous ves-

sels, destined for the secretion of turpentine; and are so large, as to be distinctly visible to the naked eye.

2. The Wood lies betwixt the bark and pith, and consists of two parts, *viz.* a parenchymatous, and lignous. In all trees, the parenchymatous part of the wood, though much diversified as to size and consistence, is uniformly disposed in diametrical rays, or insertions running betwixt similar rays of the lignous part.

The true wood is nothing but a congeries of old dried lymph-ducts. Between the bark and the wood a new ring of these ducts is formed every year, which gradually loses its softness as the cold season approaches, and, towards the middle of winter, is condensed into a solid ring of wood. These annual rings, which are distinctly visible in most trees when cut through, serve as natural marks to distinguish their age. Plate V. *fig. 1, 2.* The rings of one year are sometimes larger, sometimes less, than those of another, probably owing to the favourableness or unfavourableness of the season.

3. The PITH, though of a different texture, is exactly of the same substance with the parenchyma of the bark, and the insertions of the wood. The quantity of pith is various in different plants. Instead of being increased every year like the wood, it is annually diminished, its vessels drying up, and assuming the appearance and structure of wood; in so much that in old trees there is scarce such a thing as pith to be discerned.

A ring of sap-vessels are usually placed at the outer edge of the pith, next the wood. In the pine, fig, and walnut, they are very large. The parenchyma of the pith, is composed of small cells or bladders, of the same kind with those of the bark, only of a larger size. The general figure of these bladders is circular; though in some plants, as the thistle, and borage, they are angular. Though the pith is originally one connected chain of bladders; yet as the plant grows old, they shrivel, and open in different directions. In the walnut, after a certain age, it appears in the form of a regular transverse hollow division. In some plants, it is altogether wanting; in others, as the sonchus, nettle, &c. there is only a transverse partition of it at every joint. Many other varieties might be mentioned; but these must be left to the observation of the reader.

PLATE V. *Fig. 1.* A transverse section of a branch of ash, as it appears to the eye.

- Fig. 2.* The same section magnified.  
 A A, The bark.  
 B B B, An arched ring of sap-vessels next the skin.  
 C C C, The parenchyma of the bark with its cells, and another arched ring of sap-vessels.  
 D D, A circular line of lymph-ducts immediately below the above arched ring.  
 E E, The wood.  
 F, The first year's growth.  
 G, The second.

II, The

PLATE V. *Fig. 2.* H, The third year's growth.  
 I I I, The true wood.  
 K K, The great air vessels.  
 L L, The lesser ones.  
 M M M, The parenchymatous  
 insertions of the bark repre-  
 sented by the white rays.  
 N, O, The pith, with its blad-  
 ders or cells.

#### SECT. IV. *Of the Leaves.*

THE leaves of plants consist of the same substance with that of the trunk. They are full of nerves, or woody portions, running in all directions, and branching out into innumerable small threads, interwoven with the Parenchyma like fine lace or gauze.

The skin of the leaf, like that of an animal, is full of pores, which both serve for perspiration, and for the absorption of dews, air, &c. These pores, or orifices, differ both in shape and magnitude in different plants, which is the cause of that variety of texture or grain peculiar to every plant.

The pulpy or parenchymatous part, consists of very minute fibres, wound up into small cells or bladders. These cells are of various sizes in the same leaf.

All leaves, of whatever figure, have a marginal fibre, by which all the rest are bounded. The particular shape of this fibre determines the figure of the leaf.

The vessels of leaves have the appearance of inosculation; but, when examined by the microscope, they are found only to be interwoven, or laid along each other.

What is called air-vessels, or those which carry no sap, are visible even to the naked eye in some leaves. When a leaf is slowly broke, they appear like small woolly fibres, connected to both ends of the broken piece.

PLATE VI. *Fig. 1.* The appearance of the air-ves-  
 sels to the eye, in a vine leaf  
 drawn gently asunder.  
*Fig. 2.* A small piece cut off that leaf.  
*Fig. 3.* The same piece magnified, in  
 which the vessels have the  
 appearance of a screw.  
*Fig. 4.* The appearance of these vessels  
 as they exist in the leaf be-  
 fore they are stretched out.

#### SECT. V. *Of the Flower.*

IT is needless here to mention any thing of the texture, or of the vessels, &c. of flowers, as they are pretty similar to those of the leaf. It would also be foreign to our present purpose, to take any notice of the characters and distinctions of flowers. These belong to the science of BOTANY, to which the reader is referred.

There is one curious fact, however, which must not be omitted, *viz.* That every flower is perfectly formed in all its parts many months before it appears outwardly; that is, the flowers which appear this year, are not, pro-

perly speaking, the flowers of this year, but of the last. For example, mezezon generally flowers in January; but these flowers were completely formed in the month of August preceeding. Of this fact any one may satisfy himself by separating the coats of a tulip root about the beginning of September; and he will find that the two innermost form a kind of cell, in the centre of which stands the young flower, which is not to make its appearance till the following April or May.

PLATE VI. *Fig. 5.* Exhibits a view of the tulip-root when dissected in September, with the young flower towards the bottom.

#### SECT. VI. *Of the Fruit.*

IN describing the structure of fruits, a few examples shall be taken from such as are most generally known.

1. A PEAR, besides the skin, which is a production of the skin of the bark, consists of a double parenchyma or pulp, sap, and air-vessels, calculary, and acetary.

The outer parenchyma is the same substance continued from the bark, only its bladders are larger and more succulent.

It is every where interspersed with small globules or grains, and the bladders respect these grains as a kind of centres, every grain being the centre of a number of bladders. The sap and air-vessels in this pulp are extremely small.

Next the core is the inner pulp or parenchyma, which consists of bladders of the same kind with the outer, only larger and more oblong, corresponding to those of the pulp, from which it seems to be derived. This inner pulp is much sourer than the other, and has none of the small grains interspersed through it; and hence it has got the name of *acetary*.

Between the acetary and outer pulp, the globules or grains begin to grow larger, and gradually unite into a hard stony body, especially towards the corculum, or stool of the fruit; and from this circumstance it has been called the *calculary*.

These grains are not derived from any of the organical parts of the tree, but seem rather to be a kind of concretions precipitated from the sap, similar to the precipitations from wine, uriac, and other liquors.

The core is a roundish cavity in the centre of the pear, lined with a hard woody membrane, in which the seed is inclosed. At the bottom of the core there is a small duct or canal, which runs up to the top of the pear; this canal allows the air to get into the core, for the purpose of drying and ripening the seeds.

PLATE VII. *Fig. 1.* A transverse section of a pear, as it appears to the naked eye.  
 A, The skin, and a ring of sap-vessels  
 B, The outer parenchyma, or pulp.

Plate VI.

Fig. 2.



Fig. 1.  
VINE LEAF

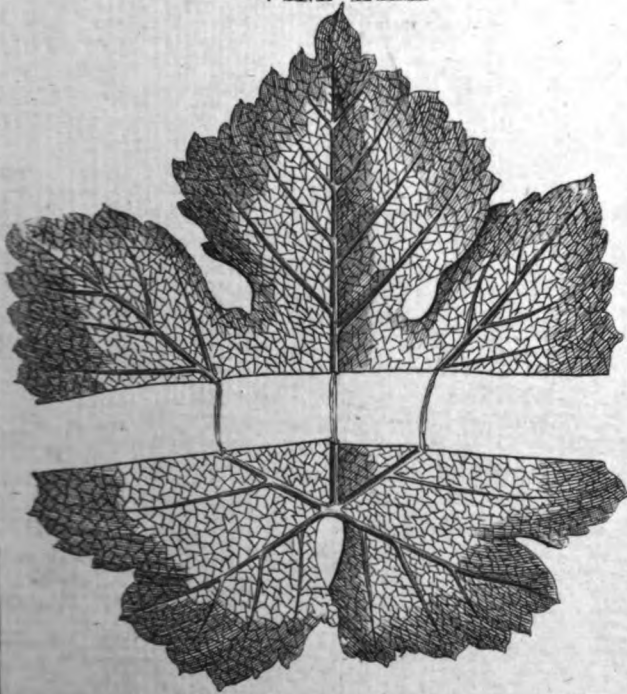


Fig. 5.  
TULIP ROOT



Fig. 3.

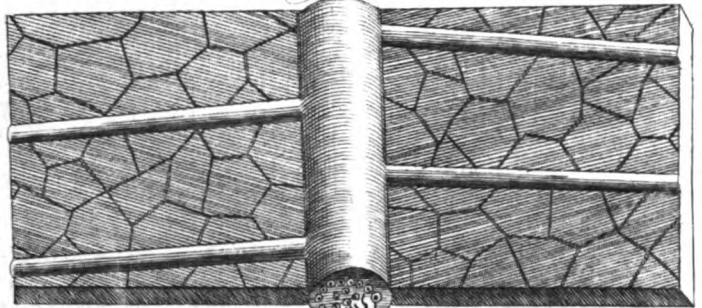


Fig. 4.

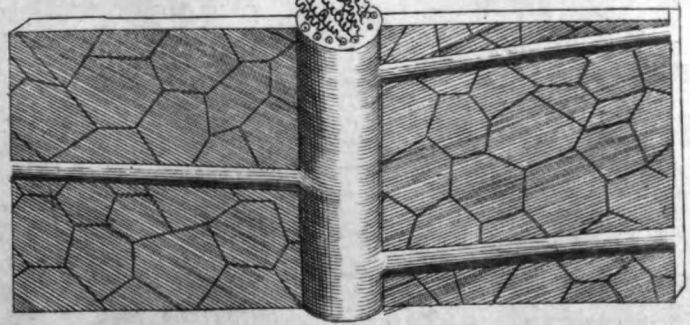
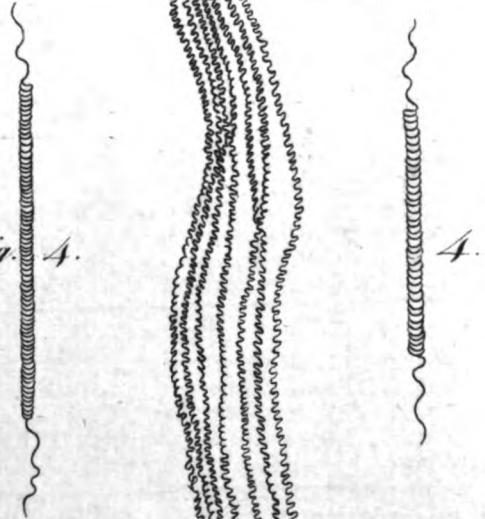








Fig. 1.  
PEAR  
Cut Transversely

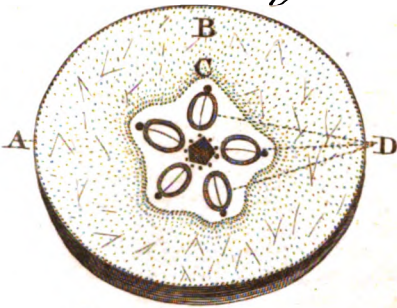


Fig. 3. as Fig. 2. Magnified  
3

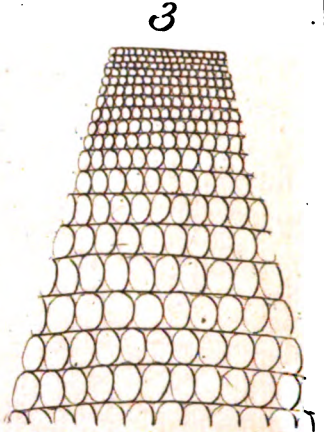


Fig. 4.  
PEAR  
Cut Longitudinally

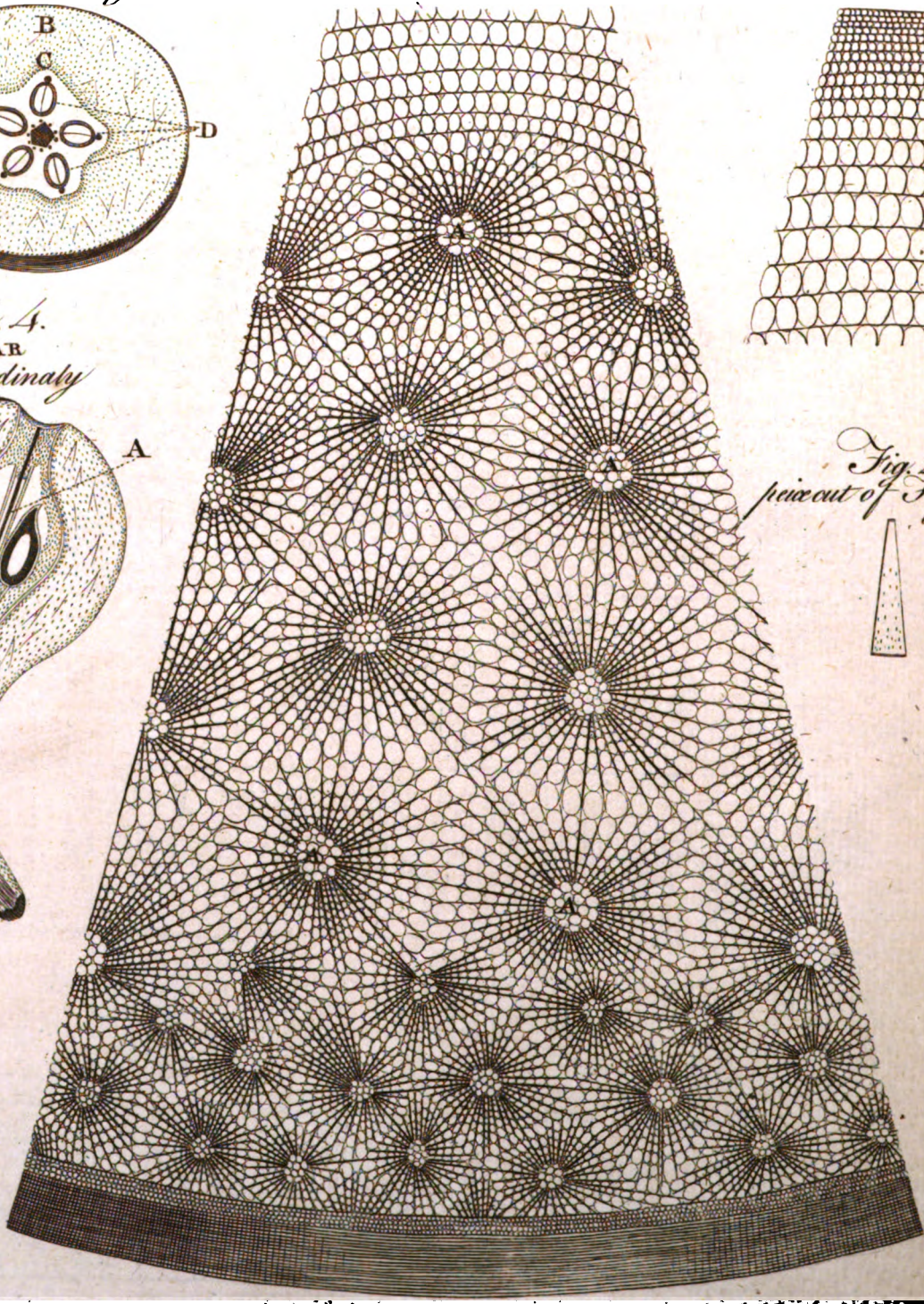
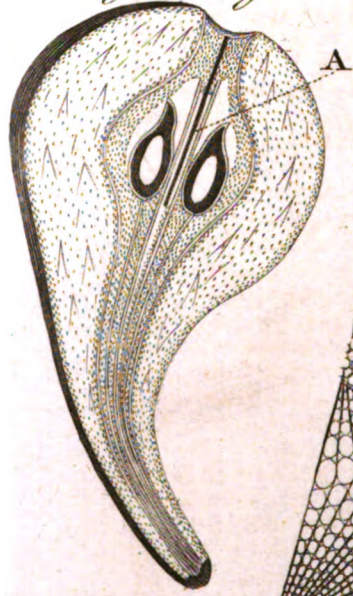


Fig. 2.  
piece cut of Fig. 1.



pulp, with its vessels, and lignous fibres interspersed.

PLATE VII. Fig. 1. C, The inner parenchyma, or ac-  
tary, with its vessels, which  
are larger than the outer one.  
D, The core and seeds.

Fig. 2. A piece cut off fig. 1.

Fig. 3. Is fig. 2. magnified.

AAA, The small grains or globules  
with the vessels radiated from  
them.

Fig. 4. A longitudinal section of the pear,  
shewing a different view of the  
same parts with those of fig. 1.

A, The channel, or duct, which  
runs from the top of the pear  
to the bottom of the core.

2. In a **LEMON**, the parenchyma appears in three dif-  
ferent forms. The parenchyma of the rind is of a coarse  
texture, being composed of thick fibres, woven into large  
bladders. Those nearest the surface contain the essential  
oil of the fruit, which bursts into a flame when the skin  
is squeezed over a candle. From this outmost parenchy-  
ma nine or ten insertions or lamellæ are produced, which  
run between as many portions of the pulp, and unite in-  
to one body in the centre of the fruit, which corresponds  
to the pith in trunks or roots. At the bottom and top  
of the lemon, this pith evidently joins with the rind,  
without the intervention of any lamellæ. This circum-  
stance shows, that the pith and bark are actually con-  
nected in the trunk and roots of plants, though it is dif-  
ficult to demonstrate the connection, on account of the  
closeness of their texture, and the minuteness of their  
fibres. Many vessels are dispersed through the whole of  
this parenchyma; but the largest ones stand on the inner  
edge of the rind, and the outer edge of the pith, just at  
the two extremities of each lamella.

The second kind of parenchyma is placed between  
the rind and the pith, is divided into distinct bodies  
by the lamellæ; and each of these bodies forms a large  
bag.

These bags contain a third parenchyma, which is a  
cluster of smaller bags, distinct and unconnected with  
each other, having a small stalk by which they are fixed  
to the large bag. Within each of these small bags are  
many hundreds of bladders, composed of extremely mi-  
nute fibres. These bladders contain the acid juice of  
the lemon.

From this short sketch of the structure and composi-  
tion of vegetables, both the farmer and philosopher may  
draw very useful and important conclusions. Some of  
them will perhaps be taken notice of in the course of this  
treatise.

PLATE V. Fig. 3. A longitudinal section of a le-  
mon.

AAA, The rind with the ves-  
sels that contain the essential  
oil.

BB, The substance correspond-

ing to the pith, formed by the  
union of the lamellæ, or inser-  
tions.

Fig. 4. A transverse section of the lemon.  
BBB, &c. The nine pulpy bags;  
or second parenchyma, placed  
between the rind and the pith;  
and the cluster of small bags;  
which contain the acid juice,  
inclosed in the large ones.

CC, The large vessels that sur-  
round the pith.

DD, Two of the large bags laid  
open, shewing the seeds, and  
their connection with the la-  
mellæ or membranes which  
form the large bags.

SECT. VII. *Of the nature and motion of the  
Sap.*

THE vessels in the roots of plants absorb moisture from  
the earth, and convey it to the trunk, branches, leaves,  
&c. This juice, when it first enters into the root, is  
crude; but as it ascends into the other parts of the plant,  
it undergoes several changes, by means of the different  
configurations of the vessels peculiar to each part. Thus  
the leaves, flowers, fruit, and seed, have all something  
peculiar in the structure and arrangement of their vessels,  
which produces considerable changes in the nature of the  
sap. It is not known how these changes are produced;  
but how the stomachs of animals make chyle from ani-  
mal and vegetable substances, or how urine, saliva, bile,  
&c. is secreted from the common mass of blood, is as  
little known. The sap likewise moves in a lateral or ho-  
rizontal direction.

Philosophers are greatly divided about what they call  
the circulation of the sap. Some contend, that it re-  
turns to the root betwixt the bark and wood. But Hales,  
who has made many accurate experiments on the subject;  
has shown, that it does not circulate, but ascends and  
descends in the same vessels; that it ascends in hot wea-  
ther, and descends in cold, like the spirits in a thermo-  
meter.

Vegetables begin to absorb sap about the beginning of  
Spring, and soon after shoot out their buds, leaves, and  
flowers.

When plants are in a state of vegetation, especially in  
hot weather, there is a great deal of superfluous sap ab-  
sorbed; but the superfluous parts are carried off by tran-  
spiration. Every part of a plant transpires; but the  
greatest quantity passes by the leaves.

Some have assigned the transpiration of plants, as the  
cause of the motion of the sap. It is undoubtedly one  
cause of this motion; because, if the transpiration be  
stopped, at a time when all the vessels are full, the mo-  
tion of the sap must stop of course. But then there is a  
previous and principal cause, viz. that power in the ves-

sels, whatever it is, that first puts the sap in motion, before any transpiration has commenced.

Heat, moisture, and air, are the three chief circumstances that promote the ascent of the sap. Hence nothing is more favourable to vegetation than warm weather accompanied with rain: on the other hand, cold dry weather is its greatest enemy. In a wet, cold season, every thing rots; and in hot dry weather every thing is parched. But the circumstances most favourable to vegetation are cloudy, hot weather, inclinable to thunder, succeeded by plentiful rains.

### SECT. VIII. *Of the Food of Plants.*

It is thought to be an important question in agriculture, whether the several kinds of plants require the same, or different nourishment.

Upon a superficial view of this question, it would appear very improbable, that the same matter could nourish such a variety of plants, differing so essentially in smell, taste, figure, &c. Much, however, may depend upon the internal structure and arrangement of the vessels. One thing is certain, that if the vessels in any plant be uncommonly small, parts will be rejected by that plant which would be absorbed by one whose vessels are larger. Nay, changes may be made in the crude homogeneous nourishment, by a small difference in the figure or action of the vessels.

It is given out as a fact, by writers on this subject, that one plant will starve another, by robbing it of its nourishment. This does not seem to affect either side of the question; for it may starve its neighbour, either by extending its roots, and requiring a greater quantity of nourishment than the other; or it may absorb the peculiar food which is necessary for the growth of the other plant. In either case, the plant is deprived of a proper quantity of nourishment.

It is likewise proposed as a difficulty, Why a poisonous plant and its antidote will grow in the same soil, and very near each other. This argument is of the same nature with the former. It may be owing either to these plants imbibing different juices from the earth, or to peculiarities in the structure and action of their vessels. These, and many other ambiguous facts, have been advanced on both sides of this question, which we shall not spend time in enumerating.

The argument drawn from grafted plants, seems more direct and decisive. A stalk of a lemon, grafted on a branch of an orange-tree, grew, ripened its fruit, and preserved the figure and all the other qualities belonging to a lemon. This plainly indicates, that the organization of the lemon had given a different modification to the juices of the orange, through the intervention of which it received its nourishment.

It is also certain, that the different parts of the same

plant have frequently various smells, tastes, &c. although the nourishment derived from the root must be the same. This is an evidence, that the different structure of parts in the same plants is capable of producing very sensible changes in the nature and quality of the sap.

Repeated experiments show, that many plants of very opposite qualities, and even trees, have been nourished and brought to maturity by the purest water alone.

It is observed, on the other hand, that different plants require different soils. This is certainly true: But what then? Does not this difference in soil rather depend upon the greater or lesser quantity, than any peculiar quality in the food? Thyme grows best in a dry soil; but it will grow equally well in earth carried from a marsh to the top of a mountain.

The roots of plants are fitted to absorb every fluid that comes within their reach. They have been found by experiment to imbibe fluids that actually poison them. From this circumstance it may be fairly concluded, that they have not, like animals, the sagacity of choosing the food that is most proper for nourishing them, and rejecting that which is either noxious or less nourishing.

Mr Dickson, author of an excellent treatise on agriculture, published in 1765, has endeavoured to fix the particular ingredients that enter into the composition of the food of vegetables. He contends, that neither earth, water, air, oil, nor salt, can be called the food of plants; but he thinks that it consists of a combination of all these substances. His arguments in support of this theory are chiefly drawn from the chemical analysis, which shows, that all these substances may be extorted from vegetables by the force of fire; and from a consideration that a due admixture of these substances (or such things as contain them) is favourable, and even necessary, to vegetation.

His last argument is good: But whoever attempts to discover the properties of plants, or the ingredients of their food, from a chemical analysis, will probably never do much service to the science of agriculture. Fire and a retort is capable of torturing either animals or vegetables into forms and qualities which never existed either in these bodies, or in their food.

We shall conclude this section with observing, that the farmer, in nourishing his plants, should be directed entirely by experience. If he knows, that putrid animal and vegetable substances, that lime, soot, marle, &c. when applied with judgment, assist the growth of his plants, and augment his crop, it is of little consequence whether he be acquainted with their chemical analysis, or the particular mode of their operation. We do not mean that he should continue obstinately in the old beaten track, as it is called; but rather that he should try whether he can by any means improve upon the old method, and that his practice should be directed according to the success of these trials.

## P A R T II.

*Of the various Operations upon the Soil, in order to prepare it for the Reception and Nourishment of Plants.*

## S E C T. I. O F M A N U R E S.

**E**V E R Y substance which promotes the growth of plants is denominated a *manure*.

As to the operation of manures, some maintain, that they give to the earth an additional quantity of the vegetable food; others, that they are of no other use than to divide the soil, and therefore that tillage may be substituted in their place. This last opinion was embraced by Mr Tull, and is the fundamental principle in his horse-hoeing husbandry. A minute division of the soil will do a great deal; but the experience of all ages shows that it will do much more by the addition of manure.

In Scotland, it is the universal practice to dung lands, that are in constant tillage, at least once in five years; and it consists with observation, that the ground is considerably enriched the first year, but that the crops gradually decline till the virtues of the dung are entirely exhausted.

Some manures lose their virtue by being long exposed to the air. If dung be kept after it is sufficiently rotted, the most valuable part of it will evaporate. Others, as lime and marles, are of an opposite nature: the longer they are exposed to the air, their utility to the land is improved. From this circumstance it is probable, that marles and lime attract something from the air which renders them more favourable to vegetation.

There is a great variety of substances which, when laid upon land, act as manures. But the most usual manures in this country are dung, lime, marles, ashes, soot, sea-weed, shells, &c.

*Of Dung.*

**D**U N G is properly the excrement of animals; but what commonly goes by that name, is a mixture of excrements, putrefied vegetable and animal substances. If dunghills be kept after they are sufficiently rotted, the oily and more volatile parts, which are the best ingredients, fly off. They should likewise be placed in a dry situation, and raised high at the sides, to prevent these parts from being carried off by water; for much water prevents the uniform putrefaction of dunghills of this mixed kind.

To promote a proper putrefaction, the dung should not be laid in small heaps, but spread thick upon the dunghill; for by this means the fermentation commences sooner, the natural sap is preserved, and the dung is prevented from being burnt, or *fire-singed*, as it is termed by farmers. Dung, when burnt in this manner, is dry, white, and useless as a manure. It is agreed, that dung-

hills ought to be covered, to prevent the exhalation of vegetable food. But the difficulty is, how to execute it. Some propose a thin layer of earth for this purpose; others, that a pit should be dug, built with flags at the side, and covered with a roof. The former would answer very well, were it not for the additions that are constantly making to dunghills; and the latter is so expensive, that few people will chuse to make trial of it. When dung comes from the stable or byre, it is mixed with straw; which absorbs the moisture, and prevents it from exhaling till the straw itself putrefies. When in this situation, if it be laid thick upon the top of the dunghill, there being but a small surface exposed to the air, the juices will be tolerably well preserved.

As dung thus loses its best qualities by being exposed to the sun and weather, it ought to be plowed in as soon as possible, after being laid upon land. If sufficiently putrefied, it should be plowed in with a shallow furrow, as its juices are washed down by the rain: It should likewise be spread very equally; for when large pieces lie scattered up and down, they become a nidus to insects and vermin.

*Of Lime.*

**L**I M E being of an alkaline nature, attracts acids: Hence it is supposed to communicate to the soil a power of attracting the vegetable food from the air. Lime is a heavy substance, and penetrates deep into the soil; it sometimes even sinks below the reach of the plow. By fermenting with acids, it breaks down and divides the soil into small particles, and makes it soft, mellow, and evidently in a state of fermentation. It likewise dissolves oils, and all animal and vegetable substances, and converts them into vegetable food. This quality renders it peculiarly useful in destroying root-weeds.

These being the general properties of lime, it is supposed to have a twofold operation upon land. When a large quantity is used, especially after being long exposed to the air, it promotes vegetation by giving a kind of stimulus to the soil, and making it exert itself. This operation of lime is not merely hypothetical; for experience shews, that land thoroughly limed may be reduced to a poorer condition by cropping, than if it had not been limed at all. It is even possible to reduce limed land to a *caput mortuum*; and the more frequently and the better the land is plowed, it is the sooner reduced to this state:

Lime also enriches land, by augmenting the vegetable aliment. When intended for this purpose, only a small quantity should be employed; as a small quantity of lime is sufficient to impregnate a large quantity of earth, and

and to communicate to it as high a degree of an absorbing quality as it is capable of receiving.

These different operations of lime is confirmed by experience, and agreeable to the practice in those parts of Scotland where lime is most used. When employed for the purpose of improving barren lands, it is laid on in large quantities, to give a stimulus to the soil, and make it exert all its vigour; and when applied to land already improved, it is used in small quantities, and repeated once every third or fourth year, to prevent too great an exertion, and impoverishing the land, by exhauiting too much of the vegetable food.

The lands in Scotland capable of the greatest improvement by lime, are the out-field and muir lands. The out-field land is generally kept three years in tillage, and carries three crops of oats; it is then allowed to rest six years, and after that is brought again into tillage. This method of cultivating out-field land is found, by calculation, to be sufficiently able to bear the expence, and allow a reasonable profit to the farmer, besides the improvement the lands derive from the lime.

In England, lime is sometimes used as a top dressing for wheat. The method is this: They sow their wheat without laying on any manure; and in the beginning of February, for every acre of land, they take 20 bushels of unflaked lime, and 4 bushels of sand, or brick-rubbish. Towards the end of the month, the lime is slaked and mixed with the sand: In the last week of the month, this is scattered by way of top-dressing over the green wheat; and as rain generally succeeds, it is soon washed down to the roots of the plant, and gives them a vigour and strength of growth that is astonishing to people who have never seen this method practised. But, if the weather inclines to be dry, the quantity of sand must be doubled, to prevent the plants from being burnt by the corrosive quality of the lime.

### *Of Marles.*

THE general characters by which marle is best distinguished, are these: It attracts and ferments with acids, and does not bake in the fire like potter's earth, which distinguishes it sufficiently from clay; upon being exposed for some time to the air and weather, it dissolves like quick-lime, and falls into a fine powder; when dry, it is friable and unctuous like lead-ore; when wet, it is soft and slippery to the touch; whereas virgin-earth is rough and gritty.

There are a great variety of marles; but they are generally reduced to three kinds: The clay, the stone, and the shell marle.

The clay and stone marles are nearly of the same nature; but the shell-marle differs from both.

### *Of Clay and Stone Marles.*

THOUGH plants will not grow in these marles, when pure; yet, when mixed with soil, they become an excellent manure.

Stone and clay marles are possessed of much the same qualities with lime, and consequently act nearly in the

same manner upon the soil. They communicate to the soil a power of attracting the vegetable food from the air, dissolve the vegetable food, and prepare it for entering the roots of plants. They likewise attract oils so strongly, that they are frequently used for extracting greasy spots out of cloth; they are therefore supposed to attract oil from the air and earth, which is the chief ingredient in the nourishment of plants.

Both the clay and stone marles are long of dissolving. Large pieces of the stone-marle are sometimes found undissolved many years after it has been laid on the land. This renders it necessary to lay on a large quantity of them, lest their effects should not at first appear.

As marle may be used with safety in greater quantity than lime, it must communicate to the soil a stronger power of attracting the vegetable food, and consequently it ought always to be preferred. Marle is likewise preferable to lime in this respect, that it is longer of dissolving; and therefore the land will continue to carry better crops for several years longer after it has been marled. However, if the soil be soft and spongy, the marle, like lime, will sink below the reach of the plough, and prevent those advantages which might naturally be expected from it.

Though marle is preferable to lime as a manure; yet it must be considered, that their operation upon the earth is the same; consequently, when marled land has been exhausted with crops, it cannot receive much benefit from an immediate application of marle a second time; for the same reason, it can receive as little advantage from lime: Dung therefore, as it contains a great proportion of the vegetable food, which lime and marles diminish, is the most proper manure for marled or limed lands exhausted with crops.

What was said with regard to the application of lime, in smaller or larger quantities, to barren lands and lands in good order, may be said with equal propriety with regard to stone and clay marles.

### *Of Shell-marle.*

THIS marle is of a different nature from the stone and clay marles. It does not dissolve with water, but absorbs and swells with it like a sponge: It attracts acids more forcibly. But the principal difference betwixt the shell-marle and the other marles consists in this, that the shell-marle contains a great quantity of oil.

This marle is therefore supposed to promote vegetation, by increasing the food of plants, by communicating to the soil a power of attracting this food from the air, by dividing the soil into small particles, and by preparing the vegetable food for being absorbed by their roots.

As shell-marle does not exhaust land like lime and the other marles, it may be repeated as often as the husbandman pleases. Its effects are likewise more sudden.

### *Of Ashes.*

THE ashes of vegetables contain a large quantity of alkaline salt; Hence they attract acids more strongly than any other substances.

The

The operation of ashes upon the soil must therefore be of the same nature with that of lime, only it is more violent and sudden, and consequently it is sooner over. This is confirmed by experience. After land has been manured with ashes, the first crop is commonly very luxuriant; but a second crop almost entirely exhausts the land. Hence ashes should be laid on in small quantities, and should not be applied to land exhausted by lime or marle; neither should they be repeated, or followed by these manures.

Burnt turf is generally recommended as a manure. Turfs are chiefly composed of vegetables; their ashes, therefore, must be of the same nature with those of wood or any other vegetable substance. It is found by experience, that the burning of turfs turns out to advantage in proportion to the number of roots they contain; and therefore land, with a tough sward of grass, is most proper to be improved in this manner.

In burning turf, the heaps must be covered in such a manner as to prevent the flame from breaking out; otherwise the most useful part of the ashes will fly off.

To prevent burnt land from being exhausted, one or two crops only should be taken, and then the land ought to be laid out in grass. Its fertility will be greatly increased, if a little dung be added after the first crop.

### Of Soot.

SOOT contains oil, salt, and earth. It promotes vegetation in the same manner as dung or shell-marle. Soot is generally applied in the Spring as a top-dressing to winter corn or grass. The effects of soot used in this way are so sudden, that they evidently appear after the first rain. But its virtues are commonly exhausted by a single crop. However, when the effects of soot are over, the soil is not exhausted, as by ashes or lime; it may therefore be repeated as often as the farmer thinks proper; or it may be followed with advantage by ashes, lime, or marle.

### Of Sea-weed.

ALL plants that grow upon rocks, within reach of the sea, are good manures. These are frequently loosened and driven ashore by the tide. They are of a soft pulpy nature, and soon putrefy.

Sea-weeds promote vegetation in the same manner as dung or soot; but their effects are not so lasting as dung; However, they are preferable to dung in this respect, that they do not produce so many weeds.

They may be applied to land in any situation, and are peculiarly proper for land that is exhausted by lime or ashes. When their effects cease, the land is not injured, and any kind of manure may be used after them.

The oftener sea-weeds are applied, the land becomes the richer. This is confirmed by experience. The lands near the shores, where the weeds have been long used as manures, are among the richest in Scotland, and have been kept almost constantly in tillage.

### Of Shells.

BEDS of shells are to be met with in many places, but particularly near the sea-shore.

These shells ferment with acids, and, like other animal-substances, contain oil, salt, and earth. Their operation is supposed to be of the same kind with that of shell-marle: But, as they take a long time to dissolve, their effects must be slower and weaker: They ought therefore to be applied in large quantities, otherwise their operation will be hardly perceptible.

Shells exhaust the land, but not near so much as lime or ashes; it is therefore improper to use them immediately after these manures.

When shells are found below the surface of the ground, as they generally are, they should be exposed to the air for some time before they are ploughed in: This not only assists their fermentation, but promotes their putrefaction.

### Of Vegetables in an entire State, or sown for Manure.

IT is a practice in many places, particularly in England, to sow turnip, pease, buck-wheat, &c. and to plough them down for manuring the land.

This practice is thought by some people to be attended with no advantage; because the plants, when ploughed down, can convey no more food to the soil than they take from it. But it ought to be considered, that some of the plants employed in this manner push their roots below the reach of the plough, and suck up the food to the surface; the seed that is sown likewise contains a great proportion of vegetable food; besides what the plants, when growing, may derive from the air, &c. From these circumstances it may be inferred, that they actually return more nourishment to the soil than they extract from it. The covering of the surface is also an advantage: Every farmer knows, that when the soil has been covered for a considerable time by a strong crop of pease, or any other corn laid down, the soil, though naturally hard and stiff, becomes soft, mellow, and free.

### Of Water.

RAIN-WATER contains a considerable quantity of vegetable food. When it falls upon land that has a descent, by running off, it must carry along with it some of the finest particles of the soil and the vegetable food contained in them. If this water, then, is let in upon a field, and allowed to settle, the land will receive from it not only the vegetable food contained in the water itself, but likewise what is contained in the particles of earth carried off from the higher grounds.

This method of manuring can only be used in fields which lie on the sides of rivers, or such as can be easily drained. In practising it, the water must not be allowed to run off violently, otherwise it does more hurt than good. Land in grass is most proper for this kind of manuring.

manuring. The firmness of the surface prevents any of the soil from being carried off when the water is draining, and the grass intangles the mud, &c. and hinders them from going along with the water.

This operation should be performed in the spring. In that season grass-lands suffer least from being over-sowed.

### SECT. III. OF SOILS WITH RESPECT TO MANURES.

SOILS are very different in their natures, and composed of very different ingredients. Some soils contain more, and others less, of the food necessary for the nourishment of plants. It is necessary to inquire into these differences, in order to discover what manures are most proper for each kind.

The soils most common in Scotland are the black loamy, the clay, the sandy, and the mossy. Of these there are many varieties, according to the different proportions of that particular kind of earth from which they are denominated. Some soils are even so blended, that it is difficult to determine what kind of earth most prevails in them.

#### *Of the black Loamy Soil.*

PURE loam seems to be nothing else but the earth of putrefied vegetables, accumulated by the successive decay of natural or artificial crops. In cultivated lands, dung and other manure greatly increase the quantity of the loam.

The principal qualities of loam are these: When allowed to rest, it acquires a degree of cohesion, but never becomes so hard and tough as clay: When turned up and exposed to the air, it becomes free and open, and easily crumbles down: When dry, it readily admits water, and swells and retains it like shell-marle; however, it only retains a proper quantity, and allows the rest to run off. It also contains oil, ferments with acids, and is of an absorbent nature.

There is no soil altogether pure; but that soil which has loam in its composition possesses in some degree all the qualities of loam; and these qualities are unquestionably the most proper for nourishing plants.

Its oils and salts afford food to the plants; the absorbent quality of which it is possessed, also attracts vegetable food from the air; its friableness, and fermenting with acids, give an easy passage to the roots to acquire this food.

Experience, the only sure guide in subjects of this kind, shows that a loamy soil is most fruitful. Some soils, when well limed or dunged, may bear as great crops as the loamy soil; but then they require a supply much sooner. The loamy soil has likewise another advantage over every other: It does not suffer so much from drought or rain, as clay and sandy soils.

All land called *in-field land* has a certain quantity of loam in its composition, probably owing to the dung

which is laid from time to time upon it. This is the only distinction betwixt out-field and in-field land.

The soil which contains a great proportion of loam, requires very little manure. It may be kept constantly in good heart by proper tillage and good management.

The common loamy soil requires manure, and no kind of manure is improper for it; dung, however, is unquestionably the best. Lime, unless managed with care, is in danger of hurting a loamy soil by exhausting it.

#### *Of the Clay-Soil.*

THE richest kind of clay-soil is that which consists of clay and loam. To discover the nature of this soil, it is necessary to know the qualities of clay.

Clay is a very solid body, and its parts adhere firmly together: It does not easily admit water, but is capable of containing a great quantity, swells but little, and does not easily part with it. When dry, clay is very hard, and becomes the harder the more suddenly it is dried. In the process of drying, it contracts unequally, and breaks out into rents or fissures where the cohesion is weakest. It ferments with acids, but has no oil in its composition.

From a slight view of these qualities it appears, that a clay-soil is not so well adapted for the nourishment of plants as the loamy: it is more subject to receive injuries from drought or rain. In a rainy season, as it is averse to part with the water after it once admits it, the roots of plants will be much weakened or destroyed by being long soaked in the water. On the other hand, in a very dry season, it becomes so hard, that the roots cannot penetrate deep enough to search for food.

These observations are fully confirmed by experience. For it is well known to the husbandman, that the produce of clay-soils are extremely uncertain, as they are liable to be destroyed by dry or wet seasons. These soils labour under another disadvantage; as they repel water, especially when it falls in small quantities, they reap no benefit from dews or slight showers.

The clay-soil is said to contain vegetable food, but does not allow it to be easily dissolved: and hence lime, marles, or ashes, are the most proper manures for it, as they divide it into small particles. These manures likewise communicate to it a greater power of absorption; and therefore they will enable it both to receive and transmit water more readily, and of course make it less subject to be injured by the weather. Clay-soils, when mixed with loam, are very rich; but, when mixed with sand or till, they are very poor. Poor clay-soils require such manures as contain the greatest quantity of vegetable food; therefore dung, shell-marle, sea-weed, &c. are the best manures for them.

#### *Of the Sandy Soil.*

THERE are two kinds of sand that enter into the composition of soils; the one consists of small particles of flint, the other of broken shells.

The



The sandy-soil which is composed of stony particles, easily receives and transmits water; and consequently is not capable of containing a sufficient quantity for promoting the growth of plants: Its particles do not adhere, and is therefore unable to support plants that have few roots and grow high. Besides, it is susceptible of greater heat from the sun than any other soil, which is apt to parch the plants. As this soil contains no oil, it must be very defective in vegetable food; and, as it has no absorbent quality, it will receive but a small supply from the air.

From the qualities of this soil, the manures most proper for it are easily discovered. Clay will make it firmer, and enable it to retain the water; but clay contains little vegetable food. Dung will supply it with the food of plants; but will not render it firm, or make it retain water. Moss will help it to retain water, and supply it with vegetable food; but will not make it firmer. A mixture of clay and dung, or of clay and moss, seems therefore to be the most proper manure for this soil.

The qualities of a sandy soil composed of broken shells, are nearly the same with those of the former kind. The only differences are, that it ferments with acids, contains oil, and is capable of being dissolved. Hence this soil must have a larger quantity of vegetable food, and must also receive a greater supply from the air. A mixture of dung and clay, or of moss and clay, is likewise the most proper manure for this soil: But if any substance could be found that could reduce the particles of the shells to a state of putrefaction, it would be preferable to any thing hitherto known for improving a soil of this kind.

### *Of the Mossy Soil.*

Moss principally consists either of live or at least uncorrupted vegetables. It must therefore have salt and oil in its composition. It does not easily putrefy, and prevents other bodies from putrefying. It swells with water like a sponge, and does not easily part with it.

To render the mossy soil fit for nourishing plants, the vegetables in it must be reduced to a state of putrefaction. This will not only supply it with vegetable food, but likewise render it firmer, and make it more easily part with water. Hence those manures which ferment most violently with acids, as the clay and stone marles, seem to be the most proper for this soil. These marles will not only raise a violent fermentation, but fill up the pores, and make the soil more solid. When the moss is deep, or has not a solid bottom, lime is improper, because it will soon penetrate beyond the reach of the plough; but, if it has a solid bottom, lime will answer very well.

It is improper to sow upon this soil till the fermentation raised by the manure is completely finished; for the violence of the fermentation sometimes throws the seeds, and even the roots, out of the ground.

Frequent ploughings make the mossy soil run much into weeds; and from this circumstance, the practice of ploughing it but seldom is found to answer better.

## SECT. IV. OF THE IMPEDIMENTS TO VEGETATION.

### I. WEEDS, as an Impediment to Vegetation.

EVERY vegetable that grows in a field, different from the particular plant that is intended to be cultivated, may be called a *weed*.

Weeds injure the plants we desire to cultivate, by robbing them of part of their nourishment, and by preventing the spreading of their roots. Some weeds, as quickening grass, extend and interweave their roots in such a manner that it is difficult to pulverise the soil by tillage. It is therefore of great importance to the farmer to know how weeds may be destroyed. Weeds are generally divided into three classes, *viz.* those that are propagated by the seed; those that are propagated by the roots; and shrubs.

#### *Of destroying Weeds that are propagated by Seed.*

WEEDS are very different in their natures. Some, if prevented from vegetating, die in a few years by lying moist in the earth; others will lie many years in this situation, without losing the power of vegetating.

The first kind may be destroyed, by turning the land infested with them into grass for five or six years; and both kinds may be rooted out by allowing them to vegetate, and then tearing up the young plants before they begin to flower.

In order to promote the vegetation of the weeds that are intended to be destroyed, the land ought to be well ploughed; if a little dung, or other manure, be applied, the crop of weeds will be increased, and their destruction will be rendered more general.

Several weeds, as the thistle, dandelion, rag-weed, &c. are furnished with a kind of down, by which they float in the air, and are carried to great distances by the wind. Farmers should be as careful to root out all weeds of this kind from the roots of hedges, banks of fences, &c. as from their arable land; for although they may have the appearance of being inoffensive in that situation, they are transported from thence in great quantities by the wind into the adjacent fields.

There is another great source of weeds, but too little attended to by farmers. It is a general practice, to throw the seeds that are separated from the corn in winnowing upon the dung-hill; and by this means they are carried out with the dung, and again sown upon the land.

#### *Of destroying Weeds that are propagated by the Root.*

THERE are many different kinds of weeds propagated by the roots. Some of them infest land that is in tillage, and others land that is in grass.

Those that infest land in tillage may be destroyed by turning it into grass for some years. This is the most effectual

effectual means of rooting out quicken-grafs, and other root-weeds of the same nature. If the soil be hard and stiff, it is the sooner cleared of weeds by being laid out in grafs; But a soft spungy soil requires to be in grafs six or seven years before the weeds are destroyed.

Those weeds that infest lands in grafs, are easiest destroyed by turning the land into tillage. Neither is it necessary to continue it long in this situation; for the weeds commonly disappear after the first ploughing.

But as, in some cases, it may be inconvenient to turn a field infested with weeds from tillage into grafs, or from grafs into tillage, it is necessary to consider whether the same may not be accomplished, without altering the situation of the land.

When land is in tillage, the weeds may be destroyed by frequently stirring and turning it over in dry weather; for when the weeds are displaced, the drought prevents them from taking root again.

Land cannot be made too fine, nor the surface too smooth, when it is intended to be freed of seed-weeds; because by that the greatest number are brought to vegetate: But, when intended to be freed of root-weeds, the rougher the surface, the weeds are the more easily destroyed; because the drought has the easier access to their roots.

If grafs-lands be infested with weeds, and it is inconvenient to turn them into tillage, the only way of destroying the weeds, is to cut them frequently, or pull them up by the roots.

Some lands, after being in grafs a few years, are liable to be over-run with fog: In this case, rolling, by making the surface firmer, will be of great use in destroying the fog. This weed, as well as others, may be destroyed by depriving it of air. This may be done by covering the surface with a crop of pease, potatoes, or other plants that lie thick on the surface. A deep trenching will, in some cases, answer the same intention.

### *Of destroying Shrubs, as Furze, Broom, Bramble, &c.*

#### I. F U R Z E.

THE common method of destroying furze (or whins) is by grubbing them out with a hoe. But it is impossible to root them out so compleatly as to prevent their springing again, especially if the land be continued in grafs. The most effectual method, therefore, is to bring the land into tillage immediately after the whins have been grubbed up. As long as it continues in tillage, no whins will appear; but if turned into grafs, they grow as numerous as ever.

To prevent this return of whins, the young plants that appear after the land is turned into grafs, should be pulled up by the roots. Unless they are very thick, this is neither troublesome nor expensive: When the ground is moist, it may be performed by young boys. If any of them rise afterwards, which is commonly the case, the same operation must be repeated every season till the land is compleatly cleared of them.

There is another scheme of management which in a

few years will effectually destroy whins. It is certain that the seeds of whins will not vegetate unless they are allowed to lie in the earth undisturbed for a considerable time. As long as land is left in tillage, although there be many whin-seeds in it, yet they never vegetate, Whin-plants do not even appear till two years after the land has been allowed to rest, or has been turned into grafs. Now, if a scheme of management be followed, by which the land is turned from tillage into grafs, and from grafs into tillage, the whins by degrees will be wholly eradicated.

It was observed above, that before lands infested with whins can be improved, the whins must be grubbed up. This operation is both tedious and expensive. The following method of rooting them out by the plough is more expeditious, less expensive, and has been tried with success.

This work must be performed by a strong Scotch plough, with a well redd beam. As it requires great force to tear up the roots, six horses should be yoked in pairs. Two drivers are likewise necessary, to prevent the horses from stepping aside. As the whins in rising are apt to entangle or choke the beam, another man is also necessary to push them off with a pitch-fork. A plough yoked and attended in this manner, will plow down whins near three feet high, with roots above four feet long, and an inch in diameter. This operation should be performed in the winter, when the land is well soaked with rain.

After the land has been ploughed in this manner, it should be allowed to lie till summer, when the whins torn up by the plough may be burned, the land harrowed, and the roots gathered. Afterwards the land may be dressed according to the judgment of the farmer; only the second ploughing should be across, that any roots which have been left may be torn up.

But when the whins are so strong that it is impossible to plough them down, they may be burned; and if the land be allowed to lie a few years after, it may be ploughed without much difficulty.

#### 2. B R O O M.

BROOM is not so bushy, and does not cover the surface so much as whins; and therefore land infested with it is more easily cleared. Though the methods recommended for destroying whins will most effectually destroy broom, a more simple and less expensive one will sufficiently answer the purpose.

If broom, especially when it is old, be cut so low as to take away all the leaves, it will never spring again. A kind of scythe has lately been invented, by which broom may be cut in this manner with great expedition. If this method be observed, it is unnecessary to bring land from grafs into tillage in order to clear it of broom.

#### 3. B R A M B L E.

THIS plant is of a very different nature from whin or broom. The root sinks deep into the earth, and spreads very wide. Though cut in the winter, it rises and comes to such perfection as to carry fruit in the summer.

It

It is therefore a difficult matter to clear land of bramble, especially when it is stony; for the bramble pushes and interweaves its roots among the stones, which renders it necessary to dig out the stones before it can be sufficiently rooted up by ploughing or tearing. However, digging out the stones, and ploughing the land in such a manner as is most proper for cutting and tearing up the roots of bramble, may be the more safely recommended, as they at the same time serve many other useful purposes.

## 2. Of WATER, as an Impediment to Vegetation.

SOME plants require a greater, and some a lesser proportion of water in their food. The plants usually cultivated in our fields are of the latter kind, and are easily injured by an over-proportion of water. Hence, water may be considered as an impediment to vegetation; and it becomes necessary to consider the most proper methods of conveying it off the land.

### Of draining Land.

SOME lands are wet from their situation, being exposed to overflowings from higher grounds, and having no proper descent to allow the water to run off.

The bottom of some land is of such a nature as to force out, in springs, the water that runs below the surface. Springs sometimes break out, because the channels, in which they run, reach the surface; and sometimes because they are interrupted in their course, which makes them force their way above ground.

The wetness of land is sometimes occasioned by violent and frequent rains; and sometimes all these causes may concur in rendering land wet.

Land that is wet from its situation may be drained in this manner: Although the wet land be so low, as to render it difficult to carry off the water; yet the water may be intercepted by a drain, before it reaches the low ground.

Land, wet by springs, lies generally in a sloping direction, which makes it the more easy to drain. When the water runs near the surface, before it breaks out, it may be intercepted by a drain drawn across the declivity, a little above the place where it first makes its appearance. But, if the channel lies deep, the drain should be drawn directly across where it springs up.

But, when the wetness of the land is owing to the climate, or a rainy season, the water cannot be intercepted by drains; however, obstructions may be removed, so as to allow the water to run off as quickly as possible. To drain land in this situation, it is necessary to lay it up in ridges properly placed, and to cut small drains across these ridges, communicating with each other, and with the furrows. By this method all the furrows betwixt the ridges become drains; the water, as it falls upon the ridges, immediately makes its way to the furrows; and, if it meets with an interruption in any of them, it is conveyed by the drains across the

ridges into some other furrow, along which it is carried off the field.

There are two kinds of drains, *viz.* open drains, and hollow drains. Hollow drains differ from open ones, in being filled with loose stones, covered with turf, brushwood, or straw, and a layer of earth thick enough to allow a plough to go easily through above. These hollow drains are attended with two advantages; no land is lost by them, and they are no impediment in ploughing.

Open drains, however, are in most cases preferable to hollow ones: They alone are capable of intercepting overflowings from higher grounds, and for carrying off water that falls in rain. The water in these cases being always on the surface, will run freely over hollow drains, especially when situated on a declivity. But hollow drains may be used with advantage in land wet by springs; because nothing more is required than to continue the channels of the water below ground, and not allow it to break out, till it arrives at a place where it can do no harm.

It will not be improper here to mention, that some soils retain water much longer than others, and consequently are more liable to be damaged by water. Soils that have a large proportion of clay, or of moss, are of this kind. As these soils naturally retain water like a sponge, casting drains, and laying the land up in ridges, will not convey it away. To drain such lands, their nature, and power of retaining water, must be changed by culture.

The clay-soil can only be drained by frequent stirring, and the application of such manures as raise a fermentation. These operations open the pores of the soil, and thereby afford a free passage to the water.

The mossy soil, on the other hand, is too open and porous, but is possessed of an absorbing quality, by which it retains the water. To drain this soil, it is necessary to condense it, and, if possible, to destroy its quality of retaining water. Frequent stirrings, and such manures as raise a fermentation, and tend to putrefy the moss, are said to render it firm and solid, and thereby both prevent it from receiving so large a quantity of water, and destroy the quality of retaining it.

### Of draining Marishes.

THE soil of marishes, being composed of dissolved vegetables, dust blown in by the winds, and earth washed down from the high grounds with which they are generally surrounded, is light and spongy, but very rich and valuable when drained.

In draining a marsh, all the stagnating water should be first carried off by a large open drain, with a sufficient fall, and as deep as the bottom of the marsh. When the stagnating water is conveyed away, the earth by degrees will subside, and become solid; and some land will thus be gained on each side: The bottom likewise soon becomes firm enough to allow the drain to be gradually carried forward through the middle of the marsh. If the springs, which supply the water, rise near the middle of the marsh, this principal drain, with a few branches on each side, where the springs are largest or most

most numerous, will be sufficient. But, if the springs be irregularly dispersed through the whole marish, as is frequently the case, side-drains parallel to the principal one will be necessary to intercept the water that comes from the higher grounds and supplies the springs. Cross drains, communicating with the parallel and principal drains, are likewise necessary; and should all be kept open till the soil hath fully subsided, and become firm; then the side-drains and cross-drains may be converted into hollow-drains, in the manner above described. But the principal drain, especially if the marish be extensive, should always remain open.

## SECT. V. OF TILLAGE.

**TILLAGE** is the operation of breaking the soil into small particles, by stirring and turning it over, laying it up in ridges, &c. In this part of agriculture, it is necessary to be acquainted with the different soils proper for nourishing plants; the instruments best adapted for stirring and turning them over; and the construction and manner of using these instruments.

Soils, with respect to tillage, may be divided into stiff and light, wet and dry, deep and shallow. This division is the more proper on this account, that the method of performing the operation of tillage has always a reference to one or more of these qualities of soil, and to no other.

The instruments employed in tillage are various; as the plough, the harrow, the roller, &c. which are again greatly diversified by differences arising from their construction and particular uses.

### I. Of the Scots Plough.

In Scotland, this plough is still the most common and the most generally understood. If properly made, it is the best plough for answering all purposes, when only one is used; though others are, perhaps, more proper for some particular purposes.

The parts of which this plough is composed are, the head, the beam, the sheath, the wrest, the mold-board, the two handles, the two rungs, the sock, and the coulter; the two last are made of iron, and all the rest of wood.

The **HEAD**, Plate VIII. fig. 1. is designed for opening the ground below. The length of the head from A to B is about twenty inches, and the breadth from A to D about five inches; C is the point upon which the sock is driven, and the length from B to C is about six inches; *a* is the mortoise into which the larger handle is fixed; and *b* is the mortoise into which the sheath is fixed.

The head is that part of the plough which goes in the ground; therefore the shorter and narrower it is, the friction will be the less, and the plough more easily drawn; but the longer the head is, the plough goes more steadily, and is not so easily put out of its direction by any obstructions that occur. Twenty inches is considered as a mean length; and five inches as the most convenient breadth.

The **SHEATH**, fig. 2. E, is driven into the mortoise,

fig. 1. *b*, and thus fixed to the head A B. It is not perpendicular to the head, but placed obliquely, so as to make the angle formed by the lines A B and E B about 60 degrees. The sheath is about 13 inches long, besides what is driven into the mortoise *b*; about three inches broad, and one inch thick.

The sheath is fixed to the mold-board, as in fig. 11. E, in the same manner as the wrest is fixed to the head in fig. 7.

The **MOLD-BOARD** is designed to turn over the earth of the furrow made by the plough; and it is obvious, that, according to the position of the sheath, the mold-board will turn over the earth of the furrow more or less suddenly. Besides, when it forms a less angle with the head than 60 degrees, the plough is in great danger of being *choked*, as the farmers term it.

The **LARGER HANDLE**, fig. 3. F A, is fixed to the head, by driving it into the mortoise *a*, fig. 1. It is placed in the same plane with the head; and its length from A F is about five feet four inches, and its diameter at the place where it is fixed to the beam is about two inches and a half, and tapers a little to the top F. About ten inches from A, there is a curve in the handle, which, when F is raised to its proper height, makes the lower part of it nearly parallel to the sheath E B. This curve is designed to strengthen the handle. The proper position of the handle is, when the top F is about three feet two inches higher than the bottom of the head A B.

The longer the handles, the plough is the more easily managed, because the levers are more distant from the centre of motion. The higher the top of the handles, the plough is more easily raised out of the ground, provided they be no higher than the lower part of a man's breast.

The **BEAM**, fig. 4. is fixed to the larger handle and the sheath, all of which are placed in the same plane with the head. The length of it, from H to I, is about six feet; its diameter is about four inches. When the plough is in the ground, the beam should be just high enough not to be incommoded by any thing on the surface.

The position of the beam depends on the number of cattle in the plough. When two horses are yoked, the beam should be placed in such a manner as to make the perpendicular distance betwixt the bolt-hole of the beam and the plane of the head about 21 inches; when four horses are yoked, two a-breast, this distance should only be about 18 inches.

The **SOCK**, fig. 5. B P, is fixed to the end of the head, and is about two feet long. In fitting the sock to the head, the point ought to be turned a little to the land or left side; because otherwise, it is apt to come out of the land altogether. When turned to the left, it likewise takes off more land; when turned upwards, the plough goes shallow; and when downwards, it goes deeper.

The **COULTER**, fig. 6. is fixed to the beam, and is about two feet ten inches long, two inches and a half broad, sharp at the point and before, and thick on the back, like a knife. It is fixed and directed by wedges, so as to make the point of it equal to, or rather a little before

before the point of the sock, and upon a line with the left side of the head. This oblique position enables it to throw roots, &c. out of the land, which requires less force than cutting or pushing them forward.

The **WREST**, fig. 7. *B D*, is fixed to the head, and is about 26 inches long, two broad, and one thick. It is fixed to the head at *B*, in such a manner as to make the angle contained between the lines *A B* and *B D* about 25 degrees. The wrest is seldom or never placed in the same plane with the head, but gradually raised from the place where it is fixed to it; that is, from *B* to *K*, as in fig. 8. The position of the wrest determines the nature of the furrow. When the wrest is wide and low set, the furrow is wide; and when it is narrow and high set, the furrow is narrow.

Fig. 9. represents the two **HANDLES**, fixed together by the two rungs. The larger handle has been already described; the lesser one is a few inches shorter, and does not require to be quite so strong. The distance of the handles at the little rung depends on the position of the wrest. Their distance at *M* and *P* is about two feet six inches. The lesser handle is fixed to the mold-board at *M*, fig. 10. and to the wrest *K B*, at *L*.

Fig. 11. represents the plough complete, by joining together figures 6. and 10. in the sheath *E B*. The wrest *B K* is supposed to make an angle with the head *A B*, as in fig. 7. and the handles joined together, as in fig. 9.

After having given such a particular description of all the parts and proportions of the Scots plough, it will easily appear how it separates, raises, and turns over the earth of the furrow. If it had no coulter, the earth would open above the middle of the sock, and in a line before the sheath; but as the coulter opens the earth in a line with the left side of the head, if the soil has any cohesion, the earth of the furrow will be wholly raised from the left side, and as the sock moves forward, will be thrown on the right side of the sheath, and by the casting out of the mold-board, or the raising of the wrest, will be turned over.

This plough, though the best general one, is not altogether perfect. As the sock is high in the middle, and round on the sides, and as the point of it is in a line with the middle of the head, a great force is necessary to raise the earth of the furrow. Besides, as the sheath is nearly in a line with the point of the sock, and to the right of the left side of the head, the earth of the furrow, as it is raised, must strike against the sheath, and a part of it, instead of being turned wholly to the right, will fall to the left side. These defects make the plough heavy to draw; and, besides, this position of the sheath renders the Scots plough improper for hoeing, as the earth that falls to the left buries the young plants in the rows.

To remedy the defects arising from the sock, it should be made straight on the land-side, so as to be in a line with the land or left side of the head; and straight also below, so as to be in a line with the under side of the head, sloping on the furrow or left side; and likewise on the upper side from the point, so as to make it, at the root, about seven inches broad, and three inches thick; at the same time sloping all the way from the land to

the furrow, so as to form the furrow-side into a sharp edge. It is obvious, that this sock will meet with less resistance than the common one, will raise the earth of the furrow wholly from the left side, and turn it as it is raised.

To remedy the defect arising from the sheath, it should be brought a little nearer the larger handle, and another sheath should be fixed a little before it, to the left or land-side of the head and beam; to this sheath the mold-board should be fixed. If this be done, the earth of the furrow, as it is raised, will be resisted by the mold-board only, and wholly turned to the right.

The **BRIDLE**, or **MUZZLE**, is another article belonging to the plough. It is fixed to the end of the beam, and the cattle are yoked by it. The muzzle commonly used is a curved piece of iron, fixed to the beam by a bolt through it. In fig. 12. *A B C* is the muzzle, *A C* the bolt by which it is fixed to the beam; *D* is the swingle-tree, or cross-tree, to which the traces are fixed; and *B* is a hook, or cleek, as it is commonly called, which joins the muzzle and swingle-tree.

Some use another kind of muzzle, fig. 13. *A B C D*. It is fixed to the beam by two bolts, and has notches by which the cleek of the swingle-tree may be fixed either to the right or the left of the beam. There are also different holes for the hind-bolt to pass through, by which the draught may be fixed either above or below the beam. *A D* is the fore-bolt upon which the muzzle turns; on *B C* are four notches, betwixt any two of which the cleek of the swingle-tree may be fixed. When the cleek is fixed at *B*, the plough is turned towards the firm land, and takes off a broader furrow; and when fixed at *C*, it is turned towards the ploughed land, and takes off a narrower furrow. *E* and *F* are the holes on each side through which the hindmost bolt passes. When the bolt is put through the highest two, these holes being thereby brought to the middle of the beam, the fore-part of the muzzle is raised above the beam, and the plough is made to go deeper; and when put through the lowest two, the fore-part of the muzzle is sunk below the beam, and the plough is made to go shallower. This muzzle may be so constructed as to have the same play with the common one. Fig. 16. *A* is the end of the beam; *B* a plate of iron sunk into it, and, with a similar one in the other side, is rivetted into it by bolts; *C* is the muzzle fixed to these plates of iron by the bolt *D*, which bolt may be put through any of the holes *E E*. From the construction of this muzzle it is plain, that it has the same play with the common one, and that by it the land of the plough may be altered at pleasure.

#### *Of the Plough with the curved Mold-board.*

THE mold-board of the Scots plough is not quite straight, but is cast out above, and more and more so as it approaches the lesser handle.

Ploughs with a curved mold-board commonly have no wrest, the mold-board serving for both. The under-part of it, which serves in place of the wrest, becomes parallel to the plane of the head as it approaches the handle; and sometimes, after it has passed the handle;

is

is made to turn inwards; and the fore-part of it, which is straight below, is more and more curved the further up it comes, resembling the bow of a ship.!

If one mold-board be preferable to another, it must be either because it throws the earth of the furrow more properly, or makes the plough more easily drawn. Now, the use of the mold-board is to raise the earth, turn it over, and, if it be taken off narrow, to shift it a little to the right hand. The common mold-board, when right made, performs all these operations gradually. But the curved mold-board, as it is cast out above in the fore-part, prevents the furrow from rising, and turns it over suddenly. In land that easily breaks in pieces, the common mold-board has the advantage, because it raises the earth of the furrow higher than the other, and leaves it more loose and open. But the curved mold-board is preferable in land that is not easily broke, for, by turning over the earth suddenly, it is apter to tear it asunder.

The plough is more easily drawn by the common mold-board, as it has less friction than the curved one.

#### *Of the Plough with the feathered Sock.*

THE difference between the feathered and the common sock will be best understood by comparing their figures. Fig. 14. is the common sock, and fig. 15. the feathered one.

From the construction of the feathered sock, it is obvious, that it must meet with greater resistance than the common sock. However, when the plough takes off the earth of the furrow broader than that part of the sock which goes upon the head, it is more easily drawn than the plough with the common sock; for the earth which the common sock leaves to be opened by the wrest, is more easily opened by the feather of the other sock. In lea, the feathered sock makes the plough go more easily, because the roots of the grass, which go beyond the reach of the plough, are more easily cut by the feather than they can be torn asunder by the common sock. The feathered sock is also of great use in cutting and destroying root-weeds. The common sock, however, answers much better in strong land.

It is proper here to add, that in fitting the feathered sock to the head, the point of it should be turned a little from the land, or a little to the right hand.

#### *Of the Wheeled Plough.*

THE Scots wheeled plough is formed by adding wheels to the old Scots plough, and giving it a curved mold-board, or feathered sock, according to the inclination of the farmer. The advantage or disadvantage of the wheels is therefore the only thing to be considered in this place.

The following are the principal advantages of wheels to a plough of this kind. Wheels regulate the plough; they make it go to a certain depth, take off the earth of the furrow of a determinate breadth, and make the plough very easy to manage. Wheels likewise make it

easy for the ploughman to keep the ridges straight, which it is difficult to do without them.

The disadvantages attending a wheeled plough are nearly equal to its advantages. It has too much machinery, which is an inconvenience in any instrument. It is improper for ploughing ridges across. It is also very inconvenient for ploughing narrow ridges; for it must be frequently altered in ploughing out a ridge. The wheel that goes in the furrow being higher than the other, when both wheels are going upon the surface, the beam must be changed from its ordinary position, and placed in such a manner as to keep the plough even, and to make it go a little deeper than ordinary. When a furrow is made for the wheel to go in, the beam must be altered again to its ordinary position; and when the ridge is near finished, so that both wheels are going in furrows, the position of the beam must be changed, to keep the plough even, and to prevent it from going too deep.

#### *Of the Four-coultered Plough.*

In England, this plough is said to be used with success. But after repeated trials by those who attempted to use it in Scotland, they have been obliged to give it up.

So many coulter in the ground at once must meet with many obstacles, which will give different directions to the plough, according to the different parts of the coulter to which the resistance is applied. Besides, it is difficult to place the planes of the coulter exactly parallel to each other; and if this be not done, they will be continually acting upon the plough in different directions. When this plough is employed for breaking up grass-grounds, which is the chief design of it, the oblique position of the coulter is apt to raise the turf in such a manner as to intangle it betwixt them, and thereby entirely stop the plough.

This plough should always be made with wheels for regulating its direction; the planes of the coulter should be exactly parallel to each other: The first couler must be set almost perpendicular, and should not go above two inches deep; the second should slope a little, and go somewhat deeper than the first, and so on to the last.

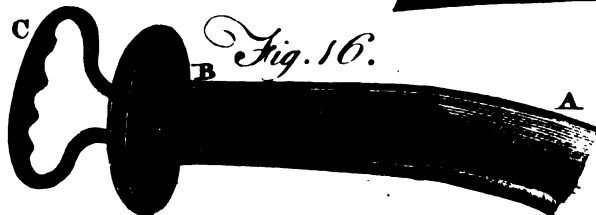
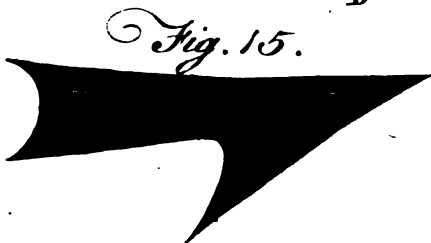
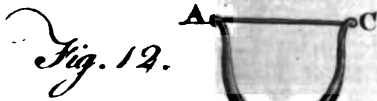
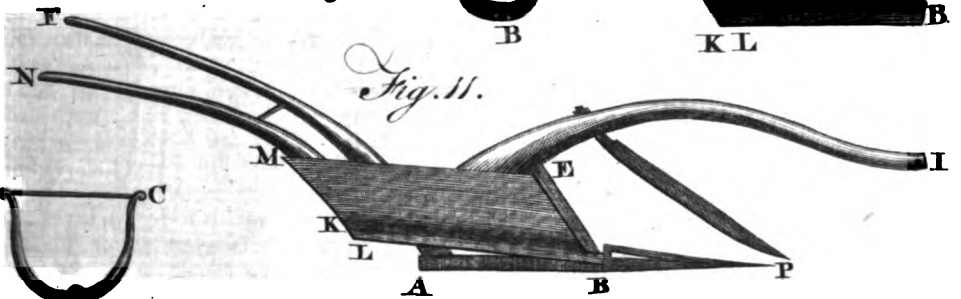
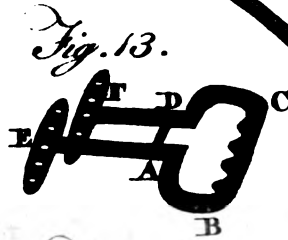
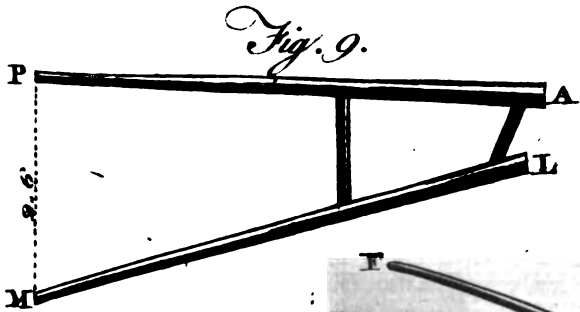
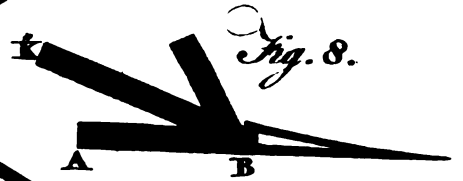
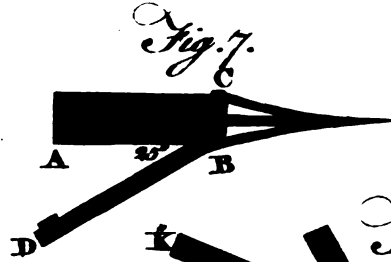
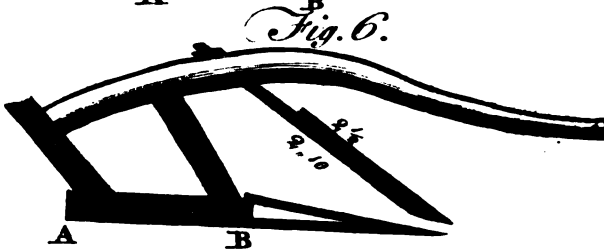
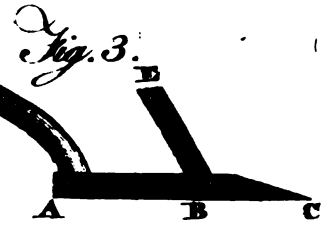
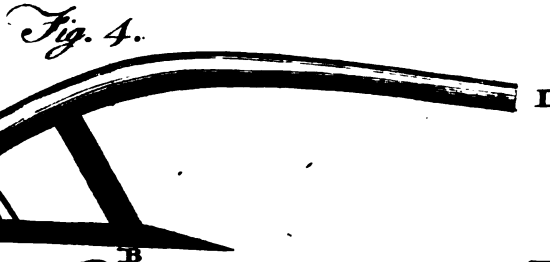
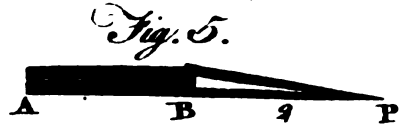
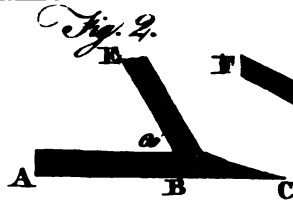
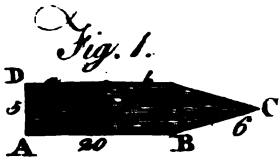
Soft meadow-land, free from stones, is best adapted to the nature of this plough.

#### *Of the Iron Plough.*

This plough is formed upon the model of the old Scots plough; only the several parts of it are shorter, and the head and sock are of one piece like the English plough-share.

This plough is lighter, and consequently more easily drawn than any other plough used in Scotland; and, as it is shorter, the friction is also diminished. Neither is the earth so apt to stick to it, and clog it while going. But these are only seeming advantages; for the lightness and shortness of it render it extremely subject to change its direction upon meeting with the least obstruction. Soft land,

Plate VIII.



A. Bull. Am. Mus. Nat. Hist.





land, with few stones, therefore, is the only land in which it can be employed with advantage.

The iron plough is subject to another inconveniency. When any thing goes wrong, it cannot be rectified on the field, but must be carried to the smithy, which is often at a considerable distance.

### *Of yoking Cattle in Ploughs.*

It is not easy to determine whether horses or oxen, or both together, are most proper for drawing ploughs; because, in this country, such a determination depends on circumstances almost as various as the number and situation of farms in it. If, indeed, real labour alone was sufficient to determine this point, oxen would be preferred; because they will stand to the draught, and overcome a resistance which horses would yield to. We shall therefore confine this head to the manner of yoking cattle, without regard to the kind of cattle employed.

The chief question on this subject is, Whether cattle should be yoked in pairs, or in a line before one another?

The most common way of yoking cattle is in pairs. Though this, upon the whole, be the best method, yet it is subject to some disadvantages. In ploughing the furrows betwixt the ridges, the cattle go upon the ploughed land, and tread it down with their feet, which is peculiarly hurtful to wet land: When there is but as much of the ridge unploughed as the cattle have hardly room to go upon, they frequently give the plough a wrong direction by going into the opposite furrow; or, which is still worse, they are apt to juggle the furrow-cattle upon the ploughed land.

To remove these inconveniencies, yoking the cattle in a line has been recommended. But this method has been attended with greater inconveniencies than those it is intended to remedy. When yoked in this manner, they go all in the furrow, which makes it necessary to give the plough more land than ordinary, either by means of the sock or muzzle; and consequently makes the draught too heavy. Besides, when cattle are yoked in a line, it gives some of them an opportunity of throwing the chief burden upon the others. There is still another inconveniency attends this method. When the cattle are all in a line, the whole force is applied to the direction of the traces of the hindmost horse; and consequently it cannot have such an effect on the plough as when a part of it is in a more horizontal direction.

Each of these methods, however, may be used with advantage in certain circumstances; yoking in pairs, as it is certainly the strongest draught, should be preferred in ploughing stiff land. On the other hand, yoking in a line answers best in wet land, which is liable to be much hurt by the treading of the cattle.

### *Of Ploughing.*

PLOUGHING is the action of the plough in stirring and turning over the soil. By opening the soil and enlarging the surface, it gives it an opportunity of extract-

ing the vegetable food from the air; and consequently increases the food of plants. Ploughing likewise dissolves and reduces to a state of putrefaction the dung, oils, and vegetable substances that happen to be mixed with the soil, and prepares them for entering the roots of plants. When properly managed, ploughing destroys weeds, and drains the land when too wet. Hence, ploughing is one of the most important operations in agriculture, and therefore merits the greatest attention.

When ploughing is designed to enrich the land, or increase the food of plants, the surface cannot be made too uneven; because the more of it is by this means exposed to the influence of the air.

But when the intention of ploughing is to destroy weeds, the surface cannot be made too smooth, nor the mold too much broken; because, by this management, their vegetation is promoted, and consequently they may be more completely destroyed by ploughing them in.

Again, if you plough with a view to remove wetness, the land must be laid up in high ridges; for the greater the number of furrows, and the higher the ridges, the water is more expeditiously carried off.

Thus the manner of ploughing must always depend on the object in view. It frequently happens indeed, that two or more of these objects require our attention in ploughing the same piece of land. But the methods above mentioned are perfectly consistent with each, and may be combined so as to answer any intention that may occur.

In ploughing, there are some general rules to be observed, whatever be the object in view. Thus, land should never be ploughed when it is wet, because the intention of it will be frustrated, whatever may be the nature of the soil. A stiff soil, when ploughed wet, dries suddenly, and becomes hard. If a light soil be ploughed wet, the water hinders it from being reduced to small enough particles. Besides these disadvantages, the labour becomes very severe on the cattle, and the land is much hurt by their treading.

With regard to ploughing lee, or opening up grass-grounds, the common practice in Scotland is to plough it as shallow and narrow as possible, and to set the turf upon its edge. After this single furrow, the land is sown, and if it be good, a profitable crop may be expected; and the turf will be completely rotten before next season.

On the contrary, in breaking up of barren land, it should be ploughed deep, and the turf turned on its back.

### *Of Ridges.*

It was formerly observed, that ploughing in ridges removes wetness, enlarges the surface, and consequently affords more space for the plants to extract nourishment from the soil.

When the soil is wet, the ridges ought to be narrow, and steep; because, by this means, the number of drains is increased, and the water finds its way more easily into the furrows. They should likewise be raised high in the

† P middle

middle or crown; for the higher they are raised, the more is the surface enlarged. However, if the soil be shallow, the ridges should not be raised high, as they deprive the furrows of soil.

But, in low flat-lying ground, the ridges should be made flat, in order to raise the furrows; for, in some cases, the higher the furrows are raised, it is the more easy to find a fall for carrying off the water. Flat ridges are also capable of being sown with greater exactness.

It is impracticable to give any general rule for laying out ridges. In some situations, narrow ridges are preferable to broad ones; in others, flat ridges are better than steep ones, &c. In laying out of ridges, therefore, every person must be determined in this point by the nature and situation of the soil, and the advantages or disadvantages of the different kinds of ridges.

But, whatever be the nature or situation of the soil, the ridges should always be made straight. In ploughing crooked ridges, the cattle must often go in a different direction from the plough, and are obliged to take short turnings, which hurt the land by the treading of the cattle. Besides, when the ridges are crooked, the fall for the water is diminished. In all soils too, the ridges should be made of the same breadth throughout, and equal to one another. When they are unequal, it is difficult to sow them with exactness, or to alter them when necessary; and the plough must often turn in the middle of the ridge, which hurts the land by the trampling of the cattle.

### *Of the Position of the Ridges.*

IT is a matter of some consequence to know how ridges should be placed, so as best to answer the situation of the land.

In lands that have a slope, the ridges are commonly placed in a straight line from the top to the bottom of the declivity. When the declivity is gentle, this position is very proper, as it drains the land of water. But when the declivity is great, this position allows the soil to be washed away by the rain; and the quantity of soil carried off will always be in proportion to the violence with which the current runs: Hence, in a soil situated in this manner, the ridges should be placed across the declivity, to prevent the soil from being carried down by the water. Making the ridges very narrow will, in a good measure, answer the same purpose; however, it is not so proper as placing them across the declivity.

When land is very dry, cross ridges are also of great use; for they retain the water, and prevent the soil from being washed away.

### *Of ploughing in Ridges.*

THERE are three different ways of ploughing in ridges, *viz.* gathering, casting, and cleaving.

By *gathering*, the crown and furrows of the ridge are kept in the same position in which they were before: the plough begins in the crown, and plows out the ridge, turning the earth towards the crown, where it first en-

tered. Every ridge is ploughed by itself; or the halves of two contiguous ridges may be ploughed together. By this method, as the earth on each side is turned upon the crown, and thrown up out of the furrows, the ridge must be raised higher.

By *casting*, the crowns and furrows are likewise kept in their former position: The ridges are ploughed in pairs: The plough may enter in the furrow betwixt the ridges, and plough out the ridges, turning the earth towards the furrow where it entered; or, the plough may enter in the furrow on the right side of the two ridges, then turn to the one on the left, and plough out the ridges, turning the earth to these furrows, and from the furrow that is betwixt them. By this method of ploughing, the ridges are kept of the same height in the crown, and one of the furrows made a little higher, and the other a little lower than before.

*Cleaving* is the reverse of gathering. The plough enters in the furrow on the right-side of the ridge, turns to the furrow on the left-side, and ploughs out the ridge, turning the earth from the crown towards the furrows. Every ridge is ploughed by itself, or the halves of two contiguous ridges may be ploughed together. If the ridge be raised in the crown, this method of ploughing makes it flatter, by throwing some of it into the furrows.

There is another method of ploughing used in some places, called *ribbing*. This method is performed by making furrows about two feet distant from each other. One half of the surface is untouched by the plough; and the other half, which the plough turns up in making the furrows, is thrown on the top of what remains fast. The land may be ploughed in this manner either without regard to ridges, or the plough may be made to enter and turn, as in gathering, casting, or cleaving. This kind of ploughing is seldom practised, but in the beginning of winter, and upon land to be sown with barley, after two additional clean ploughings. Although some modern improvers have condemned ribbing, it certainly has its uses: It keeps the land dry; the rain that falls is confined to the furrows, from whence it is easily carried off; it promotes the rotting of the stubble, and exposes a greater part of the soil to the influence of the air.

### *Of Harrows.*

THE harrow is an instrument employed for smoothing the surface after the land is ploughed. One horse is sufficient to draw the harrow commonly used in Scotland. Sometimes two of them go a-breast, and sometimes three. When the surface is very rough, two are reckoned sufficient for the attention of one person: But when three can be used, they make better work, and are nearly equal to two pair.

There are several kinds of harrows used in Scotland. The common one is so well known that it needs no description.

When the land is rough, the harrows are apt to start, and get a-top of each other. To prevent this, some fix pieces of crooked timber to the out-side bulls that are contiguous to one another, which, by stretching a little over,

over, keep the harrows in their proper place. Others couple the harrows in such a manner as to allow them to go before and fall back of each other, and at the same time turn upon a hinge.

When stiff land is ploughed wet, it rises in large pieces, which, when dry, become so hard, that the common harrows make no impression on them. To reduce this kind of land, a large harrow, called a *break*, has been contrived. The break-harrow is sometimes made of the same figure with the common harrow, and sometimes in a triangular form. Both kinds are made heavier or lighter according to the nature of the soil for which they are intended. Some of them are so heavy as to require six or eight cattle to draw them. But the heaviest kind are very improper for land infested with large fast stones; because their weight hinders them from starting over the stones; and therefore they are often in danger of being torn asunder by the cattle.

There is another harrow, which, though little used, will be found to be very useful in many cases. It is of the same form with the common harrow, but much broader. The teeth are at a greater distance, and consequently the teeth thinner placed; the teeth are longer than those of the common harrow, but very little thicker; and those in the fore-part slope forward. It is made of such a weight as to be easily drawn by a couple of horses. This harrow goes deeper, opens land better, covers the seed deeper, and is more proper for tearing up roots than the common harrow.

The French harrow is of a triangular form, with a joint near the angle, to which the draught is fixed. It has two handles, by which it is either made to go deep or shallow, as occasion requires. Its principal use is to level steep ridges, which it does most effectually. It is drawn across the ridges: When, at the crown of the ridge, by pressing on the handles, the harrow sinks down, and carries earth along with it to the furrows; and, when at the furrows, by lifting up the handles, the harrow is brought out of the ground, and leaves the earth behind. This operation, however, is extremely improper, unless the land be in a very dry situation, and not liable to be damaged by water.

### *Of Harrowing.*

HARROWING smooths the surface, destroys weeds, and covers the seed after it is sown.

When the intention of harrowing is to destroy root-weeds, the harrows should be drawn across the ridges. However, if such weeds are not fully torn up, the harrowing, by filling up the hollows, and defending the roots from the drought, rather promotes their growth. For this reason, harrowing is improper for destroying root-weeds, excepting after a spring-fallow, when the land is soon after to be ploughed for seed.

But the smoother the surface is made, and the more the mold is broke, the vegetation of the seed-weeds is the more effectually promoted, and of course they are the more liable to be destroyed by harrowing. If the season be favourable, the land may be harrowed several times, and as many crops of weeds destroyed.

A light spongy soil can hardly get too much harrowing; for the more it is harrowed, it becomes the firmer. But if the soil be stiff, the less harrowing it gets, the better, provided the purposes proposed can be answered.

The common method of harrowing after the seed is sown, is first along the ridges, then across, and then along again. When the ridges are flat, they may be harrowed either along or across; and the work may be begun or ended either way. But when the ridges are steep, it is improper to begin by harrowing across, because too much of the seed will be drawn into the furrows.

### *Of the Roller.*

THE roller is intended for smoothing the surface, and making the land firmer. Rollers are sometimes made of stone, sometimes of wood, and sometimes of iron: but the only essential difference of rollers lies in their weight. As rollers, in different circumstances, require to be lighter and heavier, they are generally constructed so that their weight can either be augmented or diminished.

The common roller, in turning, is very severe upon the cattle, for it does not move on its axis, but is dragged along the surface. To remove this inconvenience, a roller has lately been constructed with a division in the middle, as if two rollers were joined together. In turning, both parts of this roller move round their axis, the one forward, and the other back.

### *Of Rolling.*

ROLLING is practised with advantage, both on land lying in grass, and in tillage. It presses down mole-hills, smooths the surface, and makes pasture-grass stool, and grow thicker.

Rolling upon land in tillage, not only smooths the surface, but breaks clods that the harrow cannot reduce. In a light soil, the roller should be applied immediately after the seed is sown; it is peculiarly useful to this kind of soil, by condensing and making it firmer.

### *Of Sowing.*

IT is remarked by farmers, that the corn which is earliest sown is in general soonest ripe. However, as this operation depends on the nature of the weather, and a number of other circumstances, no precise time can be fixed for performing it.

The practice of sowing wheat, oats, barley, &c. at different times of the year, seems not to depend so much on the different natures of these grains, as on the inconveniences which would attend the sowing them all at the same time. It may however be observed, that wheat, the only grain in this country which is sown before winter, should be sown as early as possible, that its roots and leaves may be put forth before the frost comes on.

The most common method of sowing is by the hand. This method requires great skill and address in the sower: For, at the same time that he gives his arm a circular motion, to cast the seed with strength, he must open his hand

hand gradually, that it may not fall in a heap, but be properly scattered and spread. It is remarkable, that good sowers, by the force of habit, take their handful out of the sheet so very exactly, that they will sow any quantity of seed on an acre, according as it is designed to be thinner or thicker. But this dexterity in a few sowers, is itself an objection to the method of sowing by the hand; because long practice and observation are necessary to make a good sower: This remark is too well justified by experience; for good sowers are extremely rare, and, in some places of the country, hardly to be got. Besides, in sowing by the hand, especially when the land is uneven, the seed rebounds on the clods, falls into the cavities, and often the greatest part of it is collected in the furrows.

Different plants require to be sown at different depths. The same seeds, however, may be laid deeper in light than in strong soils. Wheat requires to be placed two inches and a half or three inches below the surface: And it may be laid down as a general maxim in sowing, that small seeds should always be placed nearer the surface than such as are larger. Besides the unequal distribution of the seed when sown by the hand, too large a quantity of it may be used; for, as it is placed at different depths, that which is too deep never comes up, and that which lies on the surface, which may be observed on the best harrowed land, is eat up by the birds. When seed is sown thin, and placed at equal distances by a drill, a lesser quantity of it, by leaving room to spread and branch out, will produce even a better crop than a larger quantity sown irregularly by the hand. The fact has been confirmed by repeated experiments both in our own country and in France.

## SECT. VI. OF THE CULTURE OF PARTICULAR PLANTS.

### *Of the Culture of Wheat.*

THOUGH wheat be the most valuable grain that is cultivated in Scotland, there are many places where it cannot be sown with advantage; for it requires not only a rich soil, but a warm climate.

The English writers mention about 13 or 14 different kinds of wheat; but in Scotland we seldom use more than two, *viz.* the white and the red wheat. The last is reckoned the most hardy plant, and succeeds in some soils and climates where the white kind fails. Bearded wheat is used in some places. This is likewise a hardy plant, and is not so apt to lodge, or to be shaken out by the wind, as the other kinds. It succeeds very well in wet land, and the grain produces a great quantity of flour.

The white wheat most commonly used in Scotland, is not a particular species, but a mixture of all the species cultivated in England. This mixture is probably occasioned by want of care in providing ourselves with foreign seed. It is found by experience, that, in this

country at least, wheat degenerates; for which reason a fresh supply is every year brought from the English granaries, which generally consists of a mixture of all the kinds. Now it is at least very probable, that these different kinds of wheat require different soils; and therefore the farmer should endeavour to provide himself annually with a quantity of unmixed wheat, of such kinds as are found to succeed best in Scotland.

Wheat is commonly sown either upon land that has been summer-fallowed, or after a crop of pease. In the latter case, the seed cannot be sown till October; but in the former, it is generally sown in August. However, in Scotland, we sow wheat from the beginning of August till the middle of November. Some have tried sowing wheat in the spring; but the plants were neither so vigorous, nor the grain so large, as those that were sown in autumn. The sowing of oats in autumn has likewise been tried; but, though the crop was bulky, the quantity of grain was not in proportion. Upon the whole, the month of October, seems to be the most proper time for sowing wheat; when it is either earlier or later, it is subject to a number of dangers.

The quantity usually sown upon a Scots acre, is from three to five firlots, Linlithgow measure, which is the measure always meant in this treatise. The proper quantity, however, must always depend upon the situation of the land: in proportion as it is clean and rich, a smaller quantity of seed is requisite; and in proportion as it is poor and full of weeds, a larger quantity becomes necessary.

A wet bed is most proper for wheat-feed. In the month of August, or even the beginning of September, it is dangerous to sow, if there be not as much moisture in the land as to make the feed vegetate, especially if the feed has been steeped in brine, and dried with lime. But though the danger be great in sowing when the land is very dry, yet the best situation of land for receiving feed is when it contains no more moisture than is sufficient to make the feed vegetate.

When wheat-land is light, or well reduced by fallowing, the seed should be ploughed in, or the land allowed to lie some time after it is ploughed before the wheat be sown. By this the land acquires a degree of firmness before the harrows go upon it, and the feet of the cattle are prevented from pressing the seed too deep into it.

Wheat-land should be ploughed so as to raise the ridges higher in the crown than is necessary on other occasions, in order to prevent it from being damaged by water: If the ridges are made narrower than ordinary, the same end will be served, because the water finds its way more easily to the furrows. Hence the old practice in Scotland, of cleaving for pease, and gathering for wheat, was well founded.

When the wheat is sown, and the land harrowed, the field should be carefully water-furrowed; and if there be ridges at the ends for the ploughs to turn upon in ploughing, a water-furrow should likewise be drawn betwixt them and the ridges, and the communication betwixt these and the furrows opened up.

*Of*

*Of the Culture of Rye.*

RYE is a winter-grain, and thrives very well on land that is improper for wheat. As there is hardly a good market for this grain in Scotland, it is but little cultivated. In some places, the land is prepared for it by a fallow, and good crops are reaped in this way. It may be sown in October, November, or early in the spring. It may be sown after pease or barley; but it is improper to sow it after wheat or oats, as this would encourage the growth of root-weeds, and greatly exhaust the land.

Rye is sometimes sown as a grass-feed. If it be sown with this view in September, upon a well-prepared fallow, it will afford good feeding for sheep in March and April; and after it is cut down, the land may be ploughed, and sown with barley. This practice, however, will not answer in wet land.

*Of the Culture of Barley.*

THERE are four kinds of barley used in Scotland, the common barley, the Lincolnshire barley, the Highland barley, more commonly called *rough bear*, and the Thanet.

These different kinds are sown at different seasons. The Lincolnshire barley may be sown any time during the winter, or in the spring; the common barley and Thanet may be sown in April, the beginning of May, or even later; and the rough bear may be sown in May, or the beginning of June: but the precise time of sowing must be determined by the weather and the situation of the land. When the season is favourable, the land free from weeds, and not too wet, Lincolnshire barley may be sown in February, and the other kinds sooner than the periods above mentioned.

When barley is sown in winter, or early in the spring, the land ought to be ploughed some time before; but when sown late in the spring, or in the beginning of summer, it ought to be sown immediately after it is ploughed. In winter, or early in the spring, land is in no danger of becoming too dry; but in summer, land is very liable to become too dry for the purposes of vegetation. The farmer should therefore endeavour to have all his seed sown before the season be too far advanced.

The quantity of barley sown on an acre is from two to four firlots. When the land is clean and rich, two firlots are sufficient; but when it is infested with weeds, a larger quantity is necessary.

Barley has tender roots, and is not able to push them far in quest of food; it is therefore necessary to bring land destined for barley into good tilth, and to enrich it either by manures or frequent ploughings. Barley is often sown upon land that has been fallowed, or after a crop of pease. In some places it is sown after a crop of oats; and sometimes it is repeated for two or three years successively upon the same land.

When barley is to be sown upon fallow, in stiff land not much infested with annual weeds, it should be dressed in November in the same manner as for wheat; so that Lincolnshire barley may be sown, if the winter be favour-

able, or spring barley upon the winter-furrow, if the season proves unfavourable. But when barley is to be sown after wheat, pease, or oats, the land should be ploughed as soon after harvest as possible, and laid up in such a manner as to be best exposed to the air and frost, and to secure it against damage from rain. To answer these purposes, barley-land is sometimes ribbed at this season: But ribbing stirs only a small quantity of the soil; and therefore it is better to gather it into narrow ridges of four or six furrows each, and to make proper drains for carrying off the water. As the first ploughing for barley-land is designed to cover the stubble, increase the vegetable food, and keep the land dry, it need not be very deep, but ought to be as broad as possible, provided it be clean ploughed.

If it be proposed to dung barley-land, the dung may be laid on during the winter-frost, and ploughed in as soon as the land is in proper condition. When the dunging is delayed till immediately before the last ploughing, or seed-furrow, the land, especially if it be of a stiff nature, is in danger of being battered so as to rise in large clods when ploughed.

In steering, the ploughing should be as deep as the plough can go, and the soil allows: For by deep ploughing at this season, part of the earth that has been exposed to the air through the winter, and part of it turned up by the ordinary ploughing, are mixed together for the nourishment of the crop. In steering, the furrows should not be so broad as in the former ploughing; on the contrary, the narrower they are the better. Cross-ploughing is very proper at this season, if the land be so dry as to allow it.

After steering, the land should be well harrowed. It makes the weeds spring, retains the sap, and, if the land be tolerably dry, takes out the roots of the quickening-grass. But, if the land be in no danger of losing the sap, the harrowing may be delayed for some time after it is ploughed; for by this method a greater number of weeds are destroyed.

Though, in general, frequent ploughings are beneficial, yet ploughing when the land is wet is destructive. When the spring is wet, the barley-land in many places is not in a proper condition to be sown. In this case, the steering-furrow must be omitted, and the land should get the seed-furrow as soon as it is in a proper condition.

When barley is to be sown a second time upon the same land, without any other crop intervening, two ploughings are sufficient.

As our summers in Scotland are sometimes very wet, barley-land should be water-furrowed, and dressed up in the same manner as wheat-land.

*Of the Culture of Oats.*

THE oat is a very hardy plant, and its roots are strong, which enables it to procure food where many other plants would starve; and hence the practice of giving less culture to oats than to any other grain.

There are three kinds of oats used in Scotland, the white, the black, and the grey. The white is the most common,

common, and used in all the low countries; the black is the hardiest, and is used in the cold hilly countries; and the grey is often sown with success upon light gravel or sand. The white is again divided into two kinds, called *cold seed* and *hot seed*. There is scarcely any difference in appearance betwixt these; but the hot seed ripens eight or ten days before the cold. Experience must determine which of them ought to be chosen for seed.

Though the oat be a hardy plant, and does not easily degenerate, yet the changing of seed is universally allowed to be a good practice. This change should always be made from a warm soil to a cold, and from a cold to a warm.

Oats are often sown upon grass-ground newly broken up, or, which is the same thing, upon lee once ploughed. They are likewise often sown after barley, sometimes after wheat, sometimes upon fallow, and sometimes they are repeated for several years successively upon the same land.

In ploughing lea for oats, when the land is soft and mellow, the plough should go as shallow as possible; and the earth of the furrows should be set upon its edges, to allow the harrows to have the greater impression in tearing it. But when the land is stiff, or the turf very tough, it is necessary to plough deeper, and to turn the turf fully over, so that the harrows may raise a kind of mold upon its back to fill up the hollows, and to nourish the seeds. When oats are to be sown upon lee, the land ought to be ploughed early in winter, that it may receive the greater benefit from the air and frost.

It is usual to lime lea-ground intended for oats. This is a very good custom; for lime promotes the corruption of the grass-roots, by which the land is sooner reduced. It is likewise common to spread the lime upon the sward some time before the land is ploughed: This is also very proper; for the lime is intangled in the sward, and is not so apt to penetrate too deep.

Oats are generally sown after barley; and the land is ploughed as soon as the wheat-seed is made, and the barley-land has got the first furrow. The stiff land, and land in danger of being damaged by wetness, should be first ploughed, to give the one the benefit of the winter-frost, and to put the other out of danger. It is likewise an advantage to light and dry land to be ploughed early in the season, as it makes the stubble rot sooner, and exposes the soil longer to the air.

It was formerly observed, that oats are sometimes sown upon fallow. In the hilly countries, they often fallow the land that has been in lea for some years; and they find that this practice does better than giving it only one ploughing in the winter before the seed is sown. In the low countries, this practice of fallowing for oats is found to succeed very well. The fallow for oats should be managed through the summer in the same manner as if for barley or wheat. Before winter, it ought to get the last furrow, and be laid up in proper ridges, to preserve it dry during the winter.

Oats may be sown in any of the winter-months, or in the month of March. Some people have sown oats so early as the beginning of November, and have had good crops. But, if the land be properly laid up in

winter, it is better to delay the sowing till March.

The quantity of oats generally sown upon an acre, is from four to five firlots; and should always get a dry bed.

### *Of the Culture of Pease.*

THE pea is a grain very different from any of those already mentioned. A crop of it is not so valuable, though it is much used in some places for bread.

The straw of pease is reckoned better for feeding horses than the straw of any other grain. A crop of pease does not require such a quantity of nourishment as a crop of any of the other grains mentioned above. When the crop is good, the straw covers the ground, and destroys all the small weeds by depriving them of a free communication with the air. Pease likewise minutely divide the particles of the soil; besides, they push their roots much deeper than any of the white grains, and extract part of their nourishment from below the reach of the plough.

There are two kinds of pease cultivated in Scotland, the white and the grey. The white is most common, and consists generally of a mixture of several kinds. All of these kinds seem to be species of the pea cultivated in our gardens. The grey pea seems to be a species of the vetch or tare. This is the hardiest plant of the two, and thrives on soils where the white pea does not succeed.

The straw of the grey pease, and the pease themselves, are better for horses than those of the white. The farmer should therefore cultivate this pea where the other does not thrive, although the value of the grain be inferior.

The white pea, like the oats, is divided into hot seed and cold seed. The sowing of the hot seed may be delayed three weeks after the cold seed is sown, and yet the pease will come as soon to maturity.

The time of sowing is from the first of February to the end of April. The early sown pease have the best chance to produce a crop of corn, and the late sown to produce a crop of straw. However, when the land is clean and in good heart, the pease may be sown early; because, on such land, a good crop both of corn and straw may be expected. But if the land be foul or wet, the sowing of pease should be delayed as long as possible; because on such land the crop is more precarious, and the failing of a crop of pease gives such encouragement to weeds, as to endanger the following crops likewise. In such a case, to prevent the bad consequences that may follow, the crop should be ploughed in; for when a bad crop of pease is allowed to stand, it does more harm to the land than all the value of the crop.

The quantity of pease sown upon an acre, is from 4 to 5 firlots. If the intention of sowing pease be to obtain straw, and enrich the land, they should be thick sown; because in that case they have a better chance to destroy the weeds, and to cover the surface. But when the principal design is to have a crop of corn, they should be thinner sown; for, when thin sown, they have more air, and fill better.

Pease are commonly sown after oats or barley, and sometimes

sometimes after wheat. Seldom more than one ploughing is given to pease, and they are usually sown immediately after it. The reason of this practice is, that the seed may be better covered; for the sooner that any grain is sown after ploughing, it is always the deeper covered. If rain falls soon after pease are sown, it makes them swell and come above ground, and then they are in danger of splitting, and of being destroyed by vermin.

Sometimes pease are sown and ploughed in. This answers very well in light land, particularly after a crop of barley, the culture of which opens the soil.

Land designed for pease is generally cloven. This is a good practice when the ridges are steep, as all of them were formerly. As wheat or barley are commonly sown after pease, the land must be ploughed before winter. Gathering is the most proper way of ploughing before winter, and this follows best after cleaving. But if the ridges be not high, casting is the best method of ploughing for pease; or, if the ridges be flat and narrow, the land may be ploughed in the ordinary way, reversing the former ploughing, and turning the furrows into the crowns. Though pease are generally the lowest-priced grain, yet sometimes they rise to a great price, when the prices of other grains are moderate. This makes the sowing of seed an article of great importance. By sowing in drills, one sirlot will serve for an acre as completely as four in the broad cast-way: But the advantages of drilling fall to be considered afterwards.

### *Of the Culture of Beans.*

WHAT has been said with regard to the culture of pease, may be applied to beans. However, it is necessary to observe, that the bean pushes its roots further down than the pea; and therefore requires a deeper soil. The lands in Scotland, where beans are most commonly sown, and where they succeed best, are deep and wet clays.

In some lands, the crops of beans are very great, and almost as valuable as any grain. There is no crop succeeds better in the drill-husbandry than a crop of beans.

### *Of the Culture of Rye-grass.*

RYE-GRASS is the most common of all the artificial grasses cultivated in Scotland, and not the least valuable. It is a fibrous-rooted plant, and binds the soil; this circumstance has led many to think, that it greatly impoverishes land. However, the culture of this grass is attended with several peculiar advantages. It destroys weeds, particularly the quickening-grass, and grows upon soils which will not answer for any of the other artificial grasses. A shallow, wet, spongy soil, or one which has a mixture of moss in it, is unfit for clover of every kind; but experience shows, that rye-grass, when unmixed with clover, will succeed upon any of these soils.

Rye-grass is usually sown along with a crop of barley or oats. When sown along with barley, the field should be rolled, or well harrowed, to preserve the sward at the dry season of the barley-seed. This precaution is not

so necessary, when the rye-grass is sown along with oats; because the land on which oats are sown is generally firmer, the sowing season is earlier, and consequently not so liable to be too dry.

This grass seldom hurts the crop of corn. On the contrary, when the soil is loose and open, it makes it firm, and prevents the corn from lodging.

Though the common method is to sow rye-grass with corn, yet, when the land is poor, it is better to sow it by itself, and still better to summer-fallow, and sow it in autumn. But, as the land by fallowing is made open and loose, and as the ploughing and sowing are near the rainy season, cattle ought not to be allowed to pasture upon it during the winter, except in the time of hard frost. Even when sown in the spring, the farmer should not allow much pasturing on it, especially in wet weather. But, if sown by itself, cattle may safely pasture upon it in the winter, as the roots, having nothing to obstruct their progress, penetrate deeper, and spread wider, than when any other grain grows along with it. This practice, however, can only be followed with safety in very clean land; otherwise weeds are apt to rise along with it, and prevent the surface from being covered; which of course will keep the soil open.

Rye-grass is sometimes sown for hay, and sometimes for pasture. When for hay, from two to four sirlots are commonly sown upon an acre.

Rye-grass rises very early in the spring, and, if the soil be dry and warm, affords good pasture all the winter. It is very hardy, stands the frost, and, if continued in pasture, does not wear out in many years. The best way of managing it is, to eat it down in the spring and beginning of summer, and then to let it rest till autumn. When allowed to get up in summer, it runs to seed, and becomes disagreeable to the cattle. Besides, by this method of managing rye-grass, a good crop may be expected in autumn.

When properly managed, rye-grass makes very good hay; and there is such a demand for the seed, that the farmer is often tempted to let it stand till the seed is perfected, and then to thresh it. When this is done, the hay can never be good; because the sap is exhausted, the stalk becomes dry and withered, and affords little nourishment to cattle. The hay ought therefore to be always cut before the seed ripens. This practice not only makes the best hay, but is likewise of great advantage to the land; for, when plants are allowed to perfect their seeds, the land is much more exhausted, than when they are cut before that period.

### *Of the Culture of Clover.*

THOUGH clover be used for the same purposes as rye-grass, it is, however, a plant of a very different nature. It has a large tap-root, which penetrates the soil perpendicularly downward, and opens the earth and makes it free: The roots of clover cannot penetrate the soil, unless it be free and open. Hence, a dry, open, deep soil, free from quicken-grass, is the most proper for this plant.

There are several kinds of clover cultivated in Scotland,

land, distinguished by the colour of their flowers, *viz.* the red, the white, and the yellow. The red is the largest plant, has the strongest stalk, and broadest leaves. The yellow sometimes grows tall, but the stalk is small. The white is the smallest plant, and is sometimes called *hop-clover*, from the resemblance its flowers bears to those of the hop.

Both the seasons and methods of sowing clover are various. Most of the English writers recommend the autumn. It has frequently been tried, at this season, in Scotland without success. When sown in spring, it answers much better in this country.

The common way of sowing clover, both in Scotland and England, is along with wheat, oats, or barley, in the spring. This method is sometimes attended with disadvantages. The clover sometimes hurts the corn, and the corn the clover. However, these disadvantages are probably more than over-balanced by the corn's protecting the clover from drought when very young, which it is much exposed to, especially when sown in the spring.

As the lodging of corn destroys all plants that are below; to prevent this, the corn sown along with clover ought to be sown thin, and the land made very clean of weeds.

Sometimes, in a wet season, the clover gets a-top of the corn, and destroys the crop. This seldom happens when it is sown with barley or wheat; because it is much later in the season when sown with barley than when sown with oats, and therefore is not so far advanced at harvest; and the wheat is advanced so far before the clover-seed is sown, that the clover can never get the better of it. To prevent the clover, then, from hurting the corn, it may be sown early in the season with wheat, or late in the season with barley. The Thanet barley, from the strength of its roots and stalk, is not so apt to lodge as the common barley; and, of course, it is the most proper kind to be sown along with clover. But, as all kinds of barley are more apt to lodge than oats, and as the season for sowing oats is more proper for sowing clover than the season of sowing barley, the farmer, when it is equally convenient for him, should prefer the sowing of clover with oats.

When clover is sown with barley or oats, after these grains are sown, and the land harrowed, the clover-seed is thin sown, and then the land is again harrowed or rolled. When the clover is sown with a crop of wheat, the clover is sown in the spring, and afterwards the wheat is rolled. It is common to sow clover-seed without any preparation given to the land; but it is better to harrow it before sowing. The harrowing does no harm to the wheat, and it makes the roller cover the seed more effectually. Clover-seed may be sown in the same manner amongst oats or early-sown barley. Some time after the corn has come up, the land may be harrowed, and the clover sown. If the weather be dry, the different parts of the operation should succeed one another as quickly as possible. The harrows should be immediately followed by the sower, and the sower by the roller, to prevent the drought from penetrating too deep.

The English writers differ widely as to the quantity of clover-seed proper to be sown on an acre. However,

the farmers in Scotland, who sow clover with oats or barley, find, that from 10 to 16 lb. of red, or from 12 to 18 lb. of white clover on the acre, produces a very good crop.

Clover, like rye-grass, is sometimes sown for hay, sometimes for pasture, and sometimes for both. The red clover is the most proper for hay, the white for pasture; and, when both are intended, a mixture of the two answers best. When red clover is sown without being mixed with any other kind, the farmer ought to bring his land into tillage again in two or three years: For, after the second year, a crop of this kind of clover is of little value.

When white clover is sown by itself, the farmer must not expect a crop of hay; for it seldom rises to such a height as to produce a good crop: But, to balance this, the field may be kept long in pasture, as this clover continues till wore out by the natural grass of the soil.

When a mixture of the two are sown, some crops of hay may be taken, and then the land may be allowed to lie some years longer for pasture. The red clover affords the crops of hay; and the white remains till the natural grass rises. In this case, there is commonly sown upon the acre, from 8 to 12 lb. of red clover, and from 6 to 8 of white. But these proportions may be varied according to the judgment of the farmer.

In Scotland, seldom more than one crop of hay in the season succeeds. The second crop is commonly so late, that it is very difficult to get the hay properly made. It may therefore be pastured on, or cut green for cattle. When clover is cut green for cattle, it is a proper way to feed them upon a field that needs dung. This method is preferable to feeding them in stalls; it saves the expence of carrying out the dung, and procures to the land the benefit of the urine, which is a very rich manure.

Before concluding this article, it must be observed, that red clover, while green, is dangerous to black cattle and sheep, when first given them, especially if wet with dew or rain. They ought therefore to be allowed it only sparingly at first, and brought to it by degrees. After being accustomed to it for a few days, the danger is over, and they may be allowed to use as much of it as they please.

#### *Of the Culture of Clover mixed with Rye-grass.*

RED clover makes the best green forage for cattle. An acre of it will maintain more cattle than three or four acres of common grass: But then it is not so proper for hay. Clover-hay is very troublesome in making, and is not reckoned so good for feeding as some other kinds of hay. It likewise hurts the land, by encouraging the growth of quickening-grass. To remedy these disadvantages, it is common to sow rye-grass along with it. Clover, when mixed with rye-grass, is easier made into hay; the hay itself is much better; and the rye-grass, by covering the surface, prevents the growth of the quickening-grass. The quantity sown upon the acre in this way is from 8 to 12 lb. of clover, and from 1 to 3 bushels of rye-grass.



*Of the Culture of St-Foin.*

THE writers on agriculture reckon this grass preferable to clover in many respects: They say, that it produces a larger crop; that it does not hurt cattle when eaten green; that it makes better hay; that it continues four times longer in the ground; and that it will grow on land that will bear no other crop. These are great advantages: But, as we have so little of that kind of grass in Scotland, it cannot be expected that any directions can be given concerning the manner of cultivating it, founded upon experience. We must therefore confine ourselves to such facts as are mentioned by authors of the best credit.

St-foin has a very long tap-root, which is able to pierce very hard earth. The roots grow very large, and the larger they are, they penetrate to the greater depth; and hence it may be concluded, that this grass, when it thrives well, receives a great part of its nourishment from below the *staple* of the soil: of course, a deep dry soil is best for the culture of St-foin. When plants draw their nourishment from that part of the soil that is near the surface, it is not of much consequence whether their number be great or small. But the case is very different when the plants receive their food, not only near, but also deep below the surface. Besides, plants that shoot their roots deep are often supplied with moisture, when those near the surface are parched with drought.

To render the plants of St-foin vigorous, it is necessary that they be sown thin. The best method of doing this is by a drill; because, when sown in this manner, not only the weeds, but also the supernumerary plants, can easily be removed. It is several years before St-foin comes to its full strength; and the number of plants sufficient to stock a field, while in this imperfect state, will make but a poor crop for the first year or two. It is therefore necessary that it be sown in such a manner as to make it easy to take up plants in such numbers, and in such order, as always to leave in the field the proper number in their proper places. This can only be done with propriety, by sowing the plants in rows by a drill. Supposing a field to be drilled in rows at ten inches distance, the partitions may be hand-hoed, and the rows dressed in such a manner as to leave a proper number of plants. In this situation the field may remain two years; then one fourth of the rows may be taken out in pairs, in such a manner as to make the beds of fifty inches, with six rows in each, and intervals of thirty inches, which may be ploughed. Next year, another fourth of the rows may be taken out in the same manner, so as to leave double rows with partitions of ten inches, and intervals of thirty: All of which may be hoed at once or alternately, as it may be found most convenient.

The great quantity of this grass which the writers on this subject assure us may be raised upon an acre, and the excellency and great value of the hay made of it, should induce farmers to make a complete trial of it, and even to use the spade in place of the hoe, or hoe-plough, if necessary.

The plants taken up from a field of St-foin may be set

in another field; and if the transplanting of this grass succeeds as well as the transplanting of lucern has done with Mr Lunin de Chateavieux, the trouble and expence will be sufficiently recompensed by the largeness of the crops. In transplanting, it is necessary to cut off great part of the long tap-root: this will prevent it from striking very deep into the soil, and make it push out large roots in a sloping direction from the cut end of the tap-root. St-foin managed in this manner, will thrive even on shallow land that has a wet bottom, provided it be not overstocked with plants.

Whoever inclines to try the culture of this grass in Scotland, should take great pains in preparing the land, and making it as free from weeds as possible.

*Of the Culture of Lucern.*

THE writers on agriculture, ancient as well as modern, bestow the highest encomiums upon this grass, as affording excellent hay, and producing very large crops. Lucern remains at least ten or twelve years in the ground, and produces about eight tons of hay upon the Scots acre. There is but little of it cultivated in Scotland. However, it has been tried in several parts of this country; and it is found, that, when the seed is good, it comes up very well, and stands the winter-frost. But the chief thing that prevented this grass from being more used in this country, is the difficulty of keeping the soil open, and free from weeds. In a few years the surface becomes so hard, and the turf so strong, that it destroys the lucern before the plants have arrived at their greatest perfection: so that we cannot hope to cultivate lucern with success, unless we fall upon some method of destroying the natural grass, and prevent the surface from becoming hard and impenetrable. This cannot be done effectually by any other means than horse-hoeing. This method was first proposed by Mr Tull, and afterwards practised successfully by M. de Chateavieux near Geneva. It may be of use therefore to give a view of that gentleman's method of cultivating lucern.

He does not mention any thing particular as to the manner of preparing the land; but only observes in general, that no pains should be spared in preparing it. He tried the sowing of lucern both in rows upon the beds where it was intended to stand, and likewise the sowing it in a nursery, and afterwards transplanting it into the beds prepared for it. He prefers transplanting; because, when transplanted, part of the tap-root is cut off, and the plant shoots out a number of lateral branches from the cut part of the root, which makes it spread its roots nearer the surface, and consequently renders it more easily cultivated: besides, this circumstance adapts it to a shallow soil, in which, if left in its natural state, it would not grow.

The transplanting of lucern is attended with many advantages. The land may be prepared in the summer for receiving the plants from the nursery in autumn; by which means the field must be in a much better situation than if the seed had been sown upon it in the spring. By transplanting, the rows can be made more regular, and the intended distances more exactly observed; and consequently

quently the hoeing can be performed more perfectly, and with less expence. M. Chateauvieux likewise tried the lucern in single beds three feet wide, with single rows; in beds three feet nine inches wide, with double rows; and in beds four feet three inches wide, with triple rows. The plants in the single rows were six inches asunder; and those in the double and triple rows were about eight or nine inches. In a course of three years he found, that a single row produced more than a triple row of the same length. The plants of lucern, when cultivated by transplantation, should be at least six inches asunder, to allow them room for extending their crowns.

He further observes, that the beds or ridges ought to be raised in the middle; that a small trench, two or three inches deep, should be drawn in the middle; and that the plants ought to be set in this trench, covered with earth up to the neck. He says, that if the lucern be sown in spring, and in a warm soil, it will be ready for transplanting in September; that, if the weather be too hot and dry, the transplanting should be delayed till October; and that, if the weather be unfavourable during both these months, this operation must be delayed till spring. He further directs, that the plants should be carefully taken out of the nursery, so as not to damage the roots; that the roots be left only about six or seven inches long; that the green tops be cut off within about two inches of the crown; that they be put into water as soon as taken up, there to remain till they are planted; and that they should be planted with a planting-stick, in the same manner as cabbages.

He does not give particular directions as to the times of horse-hoeing; but only says in general, that the intervals should be stirred once in the month during the whole time that the lucern is in a growing state. He likewise observes, that great care ought to be taken not to suffer any weeds to grow among the plants, at least for the first two or three years; and for this purpose, that the rows, as well as the edges of the intervals where the plough cannot go, should be weeded by the hand.

### *Of the Culture of Potatoes.*

THE potatoe is one of the most useful roots that are cultivated in this country, and is raised in a very different manner from any of the other roots. It has a number of *eyes* in it, each of which produce a separate plant. The largest potatoes are the best for seed; because, when cut according to the eyes, and properly sown, the plants are not in danger of crowding each other. The plant sends out roots in every direction to a considerable distance, and upon these the potatoes are formed.

There are several kinds both of the white and red potatoes. They succeed best in a light dry soil; and though there be but a small mixture of loam in it, if tolerably rich and properly cultivated, it seldom fails to produce a good crop. But a good crop is not to be expected from a stiff wet soil, unless it be laid up in ridges so as to make it dry, and a considerable quantity of dung laid on to render it open.

When the crop of potatoes is the chief point in view,

the land should have a ploughing before winter, especially if the soil be not very free and open. If dung be necessary, the proper time for laying it on is before this ploughing. When the potatoes are to be planted, which may be done any time in March or beginning of April, the land must again be ploughed in narrow furrows, and the potatoes dropped into every second furrow. But if the land be open and very loose, they may be dropped into every furrow; and as the plough opens the furrow for the second row, it buries the first row at a proper depth. The furrow should not be very deep; and two horses are sufficient. It is better in this case to make the horses go a-breast than in a line; because, as one of them only goes in the furrow, the potatoes are not so liable to be hurt or displaced. This method of planting them by the plough is greatly preferable to the *dibble* or planting-stick.

When a small quantity is intended to be cultivated, they may be planted with the spade. A small cross-trench or furrow should be opened with the spade at the end of the ridge. Into this furrow drop the potatoes at proper distances; and, in making the next furrow, the roots laid in the first will be covered in the same manner as is done by the plough.

According to the distance of the rows made by the plough, the distance of the plants in the rows should be regulated: One plant in a square foot is sufficient to allow them to be properly hoed. When planted in every second furrow ploughed narrow, the rows will be about 12 or 14 inches asunder. The plants may be placed at the same distance in the rows.

It is unnecessary to harrow the land after the potatoes are planted: This operation may be delayed till the weeds appear, which gives the farmer an opportunity of destroying them without any additional labour. The potatoes be planted early in the spring, or even before winter, they do not come up till May. Before that time the weeds are far advanced; and, if they be not destroyed by the harrows, the land must be hoed. Indeed, the goodness of the crop depends so much upon preventing the weeds from coming to any height, that it is necessary to hoe potatoes frequently. If the rows be wide, a kind of breast-hoe may be used to throw the earth a little on each side, by which it will be raised about the plants.

When two or three plants are in one piece, as often happens in light land, they should be cleaned with the hand at the root, and only one stalk left to each plant. This not only gives air to the roots, but also prevents much of the nourishment from going into the stalks.

When the husk that contains the seed, or the *apple*, as it is commonly called, is completely formed, the stalks may be cut down and given to cows. Milk-cows have been tried with this food; they eat it very freely, and it gives no bad flavour to the milk.

The time of taking up potatoes is commonly regulated by the market. But, if nothing be in view but the largeness of the crop, they ought to stand till October, or as long as they can be conveniently taken up before the frost sets in. The most expeditious method of taking them up is by the plough: Eight or nine persons to attend

attend the plough are sufficient. After the field is once ploughed, it ought to be harrowed, by which some of the potatoes will be raised; and, when these are gathered, it should be ploughed a second time.

### *Of the Culture of Turnips.*

TURNIPS have been long cultivated in England, and, in some places, are esteemed one of the most valuable crops that can be raised. The trials made in Scotland have been very successful, which gives great encouragement to proceed.

The goodness of the crop depends more on the openness of the soil than its richness. Land newly broke up is particularly proper for turnips. Though this kind of land be naturally poor, yet, with the assistance of a little dung, it seldom fails to produce an excellent crop. The land intended for turnips should be ploughed and laid up in ridges before winter, that it may have the benefit of the frost. This winter-ploughing, however, is unnecessary when the land is dry and light: The spring is early enough for this kind of land. It may get a second ploughing in the end of May, and a third in the middle or end of June, when the seed is to be sown. Though three ploughings are here mentioned, no particular number is intended; for the land ought to be ploughed over and over, till it be thoroughly pulverised. If dung be used, it should be well rotted, and laid on before the last ploughing.

Turnip-feed is usually sown by the hand; and about half a pound is sufficient for an acre. It should be mixed with sand, that it may be scattered the more equally. But sowing by a drill is better than sowing by the hand, as, in this way, the plants can be more easily hoed, and thinned. Turnips should be hoed as soon as the plants can be easily distinguished; for they grow quickly, and, if they meet with any obstruction from weeds, they are apt to become sickly; and, when this happens, they can never be recovered so as to produce a good crop.

Turnips may be cultivated with great success by the new husbandry. They have been tried in single, double, and triple rows, and, in alleys, from four to six feet wide, according to the situation of the land. The poorer the land is, or the more difficult to be reduced, the alleys ought to be the wider. After the ridges are formed, the turnip should be drilled upon the crowns; and, as soon as they come up, and are past all danger from the fly, they should be horse-hoed.

The turnip is proper food, either for sheep or black cattle. When the land is dry and needs manure, the sheep may be folded on it: But the fold must be removed every day; for it is improper to allow them to eat more at once than they can consume in that time. When the land is wet, or very rich, the turnip may be pulled, and the sheep fed with them on another field that needs manure. But, when designed for black cattle, they must be pulled up and given them, either in stalls or in another field, as the farmer shall find most convenient.

### *Of the Culture of Carrot.*

THE carrot is but rarely cultivated in our fields: Indeed, the present market does not encourage the cultivation of this plant. But they have lately been found to be excellent food for horses; they eat them greedily, and are well fed by them. Carrots are not difficult to raise; a very small field is sufficient, and the trial may easily be made by any farmer, at a very small expence.

The best crops of carrots, in our gardens, are produced by trenching. When the soil is hard below, though it be well dunged, it does not produce a good crop. Whenever the roots reach the hard soil, they become forked, *i. e.* the roots divide, which prevents them from growing large. Trenching makes the earth deep, and, by throwing what was on the surface into the bottom of the trench, lays good soil below for the roots to extend themselves into. Something like this must be done in our fields before we can expect a good crop.

M. de Chateavieux tried to raise a crop of carrots by the horse-hoeing husbandry, and was very successful. He sowed them in beds six feet broad, on the 4th of May. He stirred the alleys with the spade on the 15th and 27th of July, and a third time on the 6th of September. They were dug up on the 8th of November, measured from 18 to 25 inches in length, and from two to four in diameter, and weighed from 25 to 33 ounces.

Land that has a hard bottom of clay or till is improper, and it is vain to expect that such land can be prepared for carrots by the plough, without great trouble and expence. But, when land has a soft bottom, a good crop of carrots may be raised at a small expence by horse-hoeing.

As the seed, in this country, must be sown in March, the land should get a ploughing before winter, and be laid out in beds or ridges of the breadth proposed when the carrots are to be sown; the furrows betwixt these ridges should be made as deep as possible, because it is upon these furrows that the rows of carrots are to be sown. A second ploughing in winter should reverse the first, and turn the furrows into crowns; and, before the carrots are sown, one bout of the plough may raise the crown of the ridge still higher. Upon these crowns the seed must be sown out of the hand, into a small trench, drawn as straight as possible, and covered with a rake.

When the weeds first appear, the remaining part of the ridges may be ploughed out, turning the earth to the rows, and taking care not to go so near as to cover the plants. Before the seed is sown, which is some time in March, instead of ploughing the whole ridge, the plough should only go once about on the crown, to prevent the bad effects of too much moisture.

As soon as the plants can be easily distinguished, they should be hand-hoed, and thinned where they stand too thick; and after this the alleys must be regularly hoed, as directed in the culture of turnips.

It is natural to expect, that carrots raised in this way should be freer from worms, and much better every way,

way, than those raised in our gardens, except such as are sown upon newly trenched ground.

## SECT. VI. PRINCIPLES AND ADVANTAGES OF THE NEW HUSBANDRY.

THE general principles of the new husbandry may be reduced to two, *viz.* the promoting the growth of plants by hoeing, and the saving of seed; both of which are equally profitable to the farmer.

But, before illustrating these principles and advantages, it will be necessary to describe the instruments that are commonly used in cultivating land by this new method.

Plate IX. fig. 1. is a marking plough. The principal use of this plough is to straighten and regulate the ridges. The first line is traced by the eye, by means of three poles, placed in a straight line. The plough draws the first furrow in the direction of this line; and, at the same time, with the tooth A, fixed in the block of wood near the end of the cross-poll or slider B B, marks the breadth of the ridge at the distance intended. The ploughman next traces the second line or rutt made by the tooth, and draws a small furrow along it; and continues in this manner till the whole field is laid out in straight and equidistant ridges.

—Fig. 2. is a plough for breaking up lee, or turning up the bottom of land when greatly exhausted. By its construction, the width and depth of the furrows can be regulated to a greater certainty than by any other hitherto known in this country. Its appearance is heavy; but two horses are sufficient to plough with it in ordinary free land; and only four are necessary in the stiffest clay-soils. This plough is likewise easily held and tempered. A, is the sword fixed in the sizers B, which runs thro' a mortise at the end of the beam E, and regulates the depth of the furrow, by raising or depressing the beam; it is fixed by putting the pin D, through the beam and sword, and is moveable at E.

—Fig. 3. is a jointed break harrow with 24 teeth shaped like coulter, and standing at about an angle of 80 degrees. By this instrument the land is finely pulverised, and prepared for receiving the seed from the drill. It requires four horses in stiff, and two in open land. This harrow is likewise used for levelling the ridges; this is done by pressing it down by the handles where the ridge is high, and raising it up when low.

—Fig. 4. is an angular weeding harrow, which may follow the break when necessary. The seven hindmost teeth should stand at a more acute angle than the rest, in order to collect the weeds, which the holder can drop at pleasure, by raising the hinder part, which is fixed to the body of the harrow by two joints.

—Fig. 5. is a pair of harrows with shafts. This harrow is used for covering the seed in the drills, the horse going in the furrow.

—Fig. 6. is a drill-plough, constructed in such a manner as to sow at once two rows of beans, pease, or wheat.

This machine is easily wrought by two horses. A, is the happer for containing the seed; B, circular boxes for receiving the seed from the happer; C C, two square boxes which receive the seed from small holes in the circular boxes, as they turn round; and last of all, the seed is dropped into the drills through holes in the square boxes, behind the coulter D. The cylinder E follows, which, together with the wheel F, regulates the depth of the coulter, and covers the seed; the harrow G comes behind all, and covers the seed more completely. H H, two sliders, which, when drawn out, prevent the seed from falling into the boxes; and, I, is a ketch which holds the rungs, and prevents the boxes from turning, and losing seed at the ends of the ridges.

—Fig. 7. is a single hoe-plough of a very simple construction, by which the earth, in the intervals, is stirred and laid up, on both sides, to the roots of the plants, and, at the same time, the weeds are destroyed. A A the mold-boards, which may be raised or depressed at pleasure, according as the farmer wants to throw the earth higher or lower upon the roots.

### *Advantages of Horse-hoeing.*

THE advantages of tillage before sowing have already been pointed out. In this place we must confine ourselves to the utility of tillage after sowing. This kind of tillage is most generally known by the name of *horse-hoeing*.

Land sowed with wheat, however well it may be cultivated in autumn, sinks in the winter; the particles get nearer together, and the weeds rise; so that in spring, the land is nearly in the same situation as if it never had been ploughed. This, however, is the season when it should branch and grow with most vigour; and consequently stands most in need of ploughing or hoeing, to destroy the weeds, to supply the roots with fresh earth, and, by dividing anew the particles of the soil, to allow the roots to extend and collect nourishment.

It is well known, that, in gardens, plants grow with double vigour after being hoed or transplanted. If plants growing in arable land could be managed with ease and safety in this manner, it is natural to expect, that their growth would be promoted accordingly. Experience shows, that this is not only practicable, but attended with many advantages.

In the operation of hoeing wheat, though some of the roots be moved or broke, the plants receive no injury; for this very circumstance makes them send forth a greater number of roots than formerly, which enlarge their pasture, and consequently augment their growth.

Sickly wheat has often recovered its vigour after a good hoeing, especially when performed in weather not very hot or dry.

Wheat, and such grain as is sown before winter, requires hoeing more than oats, barley, or other grain sown in the spring; for, if the land has been well ploughed before the sowing of spring-corn, it neither has time to harden nor to produce many weeds, not having been exposed to the winter's snow and rain.

Fig. 1.

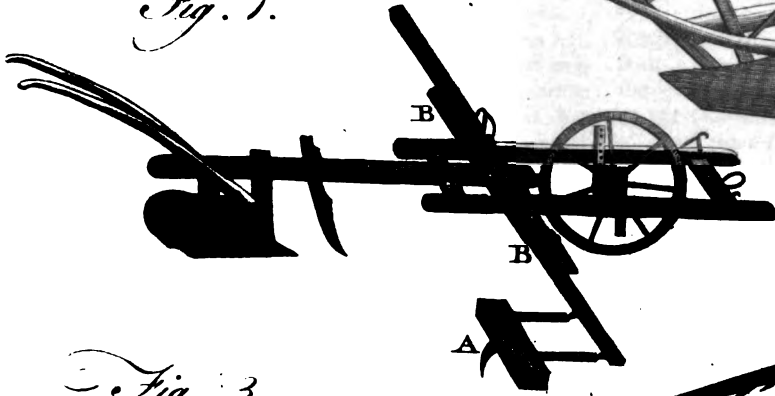


Fig. 2.

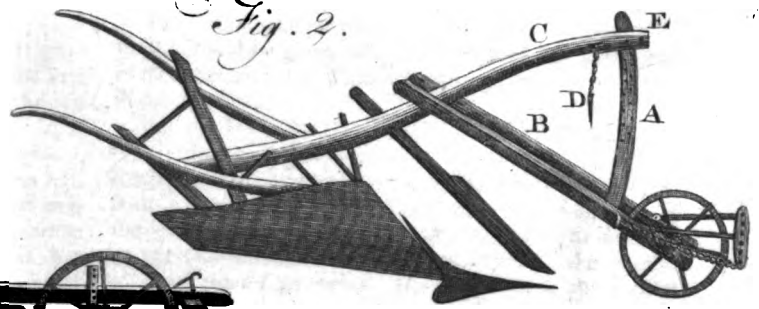


Fig. 3.

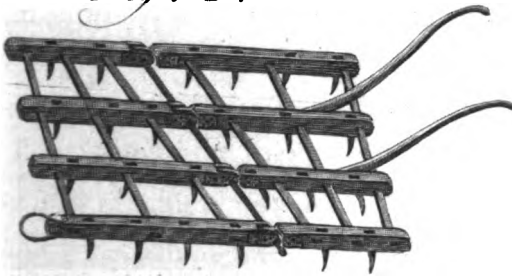


Fig. 4.

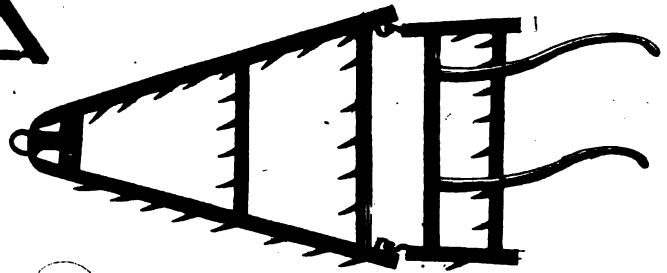


Fig. 5.

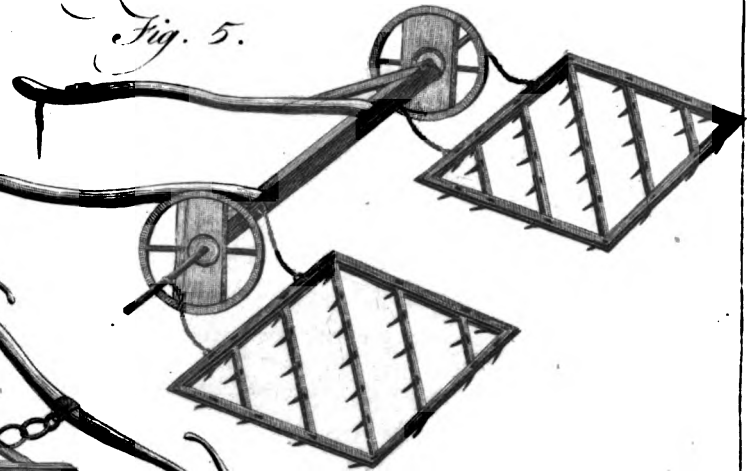


Fig. 6.

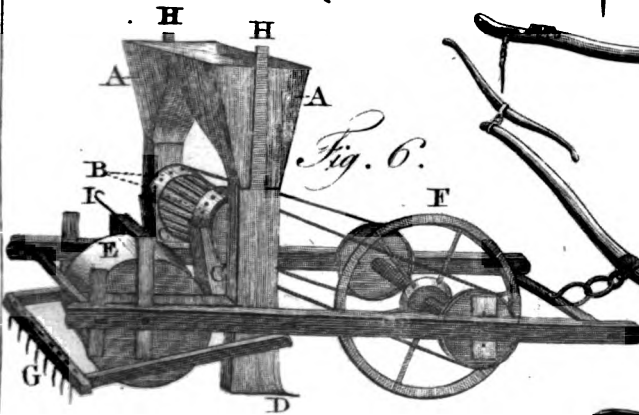
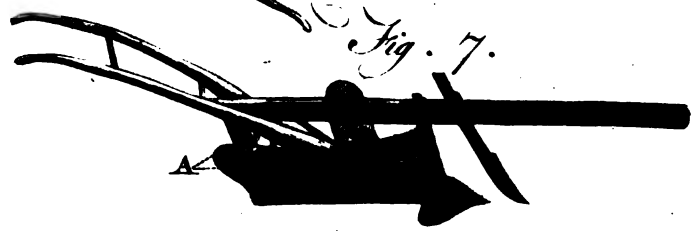


Fig. 7.



A. Bell Sculp.



*Of Sowing.*

As, in the practice of the new husbandry, plants grow with greater vigour than by the old method, the land should be sowed thinner. It is this principle of the new husbandry that has been chiefly objected to; for, upon observing the land occupied by a small number of plants, people are apt to look upon all the vacant space as lost. But this prejudice will soon be removed, when it is considered, that, in the best land cultivated in the common method, and sown very thick, each seed produces but one or two ears; that, in the same land sown thinner, every seed produces two or three ears; and that a single seed sometimes produces eighteen or twenty ears.

In the common method, as there are many more plants than can find sufficient nourishment, and as it is impossible to assist them by hoeing, numbers die before they attain maturity, the greatest part remain sickly and drooping; and thus part of the seed is lost. On the contrary, in the new method, all the plants have as much food as they require; and as they are, from time to time, assisted by hoeing, they become so vigorous as to equal in their production the numerous, but sickly plants cultivated in the common method.

*Of Hoeing.*

THE new husbandry is absolutely impracticable in lands that are not easily ploughed. Attempting to cultivate land according to this husbandry, without attending to this circumstance, that it is practicable in no land, excepting such as have already been brought into good tilth by the old method, has gone far to make it contemptible in many places.

When a field is in good tilth, it should be sown so thin as to leave sufficient room for the plants to extend their roots. After being well ploughed and harrowed, it must be divided into rows, at the distance of 30 inches from one another. On the sides of each of these rows, two rows of wheat must be sowed six inches distant from each other. By this means there will be an interval of two feet wide betwixt the rows, and every plant will have room enough to extend its roots, and to supply it with food. The intervals will likewise be sufficient for allowing the earth to be hoed or tilled without injuring the plants in the rows.

The first hoeing, which should be given before the winter, is intended to drain away the wet, and to dispose the earth to be mellowed by the frosts. These two ends will be answered by drawing two small furrows at a little distance from the rows, and throwing the earth taken from the furrows into the middle of the intervals. This first hoeing should be given when the wheat is in leaf.

The second hoeing, which is intended to make the plants branch, should be given after the hard frosts are over. To do this with advantage, after stirring the earth a little, near the rows, the earth which was thrown in the middle of the intervals should be turned back into the furrows. This earth, having been mellowed by the

winter, supplies the plants with excellent food, and makes the roots extend.

The third hoeing, which is intended to invigorate the stalk, should be given when the ears of the corn begin to shew themselves. This hoeing may, however, be very slight.

But the last hoeing is of the greatest importance, as it enlarges the grain, and makes the ears fill at their extremities. This hoeing should be given when the wheat is in bloom; a furrow must be drawn in the middle of the interval, and the earth thrown to the right and left on the foot of the plants. This supports the plants, prevents them from being aid, and prepares the ground for the next sowing, as the seed is then to be put in the middle of the ground that formed the intervals.

By this successive tillage, or hoeing, good crops will be obtained, provided the weather is not very unfavourable.

But as strong, vigorous plants are longer before they arrive at maturity, corn raised in the new way is later in ripening than any other, and must therefore be sown earlier.

In order to prepare the intervals for sowing again, some well-rotted dung may be laid in the deep furrows made in the middle of the intervals; and this dung must be covered with the earth that was before thrown towards the rows of wheat. But, if the land does not require mending, the deep furrow is filled without any dung. This operation should be performed immediately after harvest, that there may be time to give the land a slight stirring before the rows are sowed; which should occupy the middle of the space which formed the intervals during the last crop. The intervals of the second year take up the space occupied by the stubble of the first.

Supposing dung to be necessary, which is denied by many, a very small quantity is sufficient; a single layer, put in the bottom of each furrow, will be enough.

*Summary of the Operations necessary in executing the New Husbandry with the Plough.*

1. It is indispensibly necessary that the farmer be provided with a drill and hoe-plough.
2. The new husbandry may be begun either with the winter or spring corn.
3. The land must be prepared by four good ploughings, given at different times, from the beginning of April to the middle of September.
4. These ploughings must be done in dry weather, to prevent the earth from kneading.
5. The land must be harrowed in the same manner as if it were sowed in the common way.
6. The rows of wheat should be sowed very straight.
7. When the field is not very large, a line must be strained across it, by which a rill may be traced with a hoe for the horse that draws the drill to go in; and, when the rows are sown, fifty inches must be left betwixt each rill. But, when the field is large, stakes at five-foot distance from each other, must be placed at the two ends. The workman must then trace a small furrow, with

with a plough that has no mold-board, for the horse to go in that draws the drill, directing himself with his eye by the stakes.

8. The sowing should be finished about the end of September, or beginning of October.

9. The furrows must be traced the long way of the land, that as little ground as possible may be lost in headlands.

10. The rows, if it can be done, should run down the slope of the land, that the water may get the easier off.

11. The seed-wheat must be plunged into a tub of lime-water, and stirred, that the light corn may come to the surface and be skimmed off.

12. The seed must next be spread on a floor, and frequently stirred, till it is dry enough to run through the valves of the happer of the drill.

13. To prevent smut, the seed may be put into a lye of ashes and lime.

14. After the happers of the drill are filled, the horse must go slowly along the furrow that was traced. That a proper quantity of seed may be sown, the aperture of the happer must be suited to the size of the grain.

15. As the drill is seldom well managed at first, the field should be examined after the corn has come up, and the deficiencies supplied.

16. Stiff lands that retain the wet, must be stirred or hoed in October. This should be done by opening a furrow in the middle of the intervals, and afterwards filling it up by a furrow drawn on each side, which will raise the earth in the middle of the intervals, and leave two small furrows next the rows, for draining off the water, which is very hurtful to wheat in winter.

17. The next stirring must be given about the end of March, with a light plough. In this stirring, the furrows made to drain the rows must be filled up by earth from the middle of the intervals.

18. Some time in May, the rows must be evened, which, though troublesome at first, soon becomes easy, as the weeds are soon kept under by tillage.

19. In June, just before the wheat is in bloom, another stirring must be given with the plough. A deep furrow must be made in the middle of the intervals, and the earth thrown upon the sides of the rows.

20. When the wheat is ripe, particular care must be taken in reaping it, to trample as little as possible on the ploughed land.

21. Soon after the wheat is carried off the field, the intervals must be turned up with the plough, to prepare them for the seed. The great furrow in the middle must not only be filled, but the earth raised as much as possible in the middle of the intervals.

22. In September, the land must be again sowed with a drill, as above directed.

23. In October, the stubble must be turned in for forming the new intervals; and the same management must be observed as directed in the first year.

We pretend not to determine whether the old or new husbandry be preferable in every country.

With regard to this point, the climate, the situation of particular land, skill and dexterity in managing the machinery, the comparative expence in raising crops, and many other circumstances, must be accurately attended to before a determination can be given. One observation, however, may be made in favour of the new husbandry:—Though the particular modes of cultivating land by it are perhaps too limited to be universally adopted; yet it has been of great use in raising suspicions concerning the old method, and in turning the views of philosophers and farmers towards improving in general. Many real improvements in agriculture have been the consequences of these suspicions; and as this spirit of inquiry remains in full vigour, particularly in our own country, a solid foundation is laid for expecting still further improvements in this useful art.

## A G R

**AGRIFOLIUM**, in botany. See **AQUIFOLIUM**.

**AGRIMONIA**, **AGRIMONY**, in botany, a genus of the dodecandria digynia class. There are three species of this genus, *viz.* the eupatoria, repens, and agrimonoides; of which the eupatoria only is a native of Britain. The calix of the eupatoria is quinque-dentated; it has five petals, and two seeds in the bottom of the calix. It is said to be good in obstructions of the liver, &c.

**AGRIMONOIDES**, in botany, the trivial name of a species of the agrimonia.

**AGRIMONY**. See **AGRIMONIA**.

*Hemp* **AGRIMONY**. See **EUPATORIUM**.

*Water-hemp* **AGRIMONY**. See **BIDENS**.

**AGRIOCINARA**, in botany. See **CINARA**.

**AGRIPPA**, in midwifery, a term applied to children brought forth with their feet foremost. See **MIDWIFERY**.

## A G R

**AGRIUM**, in nat. hist. See **NATRUM**.

**AGROM**, the name of a disease incident to the inhabitants of the East-Indies, by which their tongues chape and cleave in different places.

**AGROPOLI**, a small town in the kingdom of Naples, and province of the Hither Principato.

**AGROSTEMMA**, or **COCKLE**, in botany, a genus of the decandria pentagynia class. The calix is monophyllous; the petals are five, and unguled; and the capsule one-valved. There are four species of the agrostemma, *viz.* the githago, a native of Britain; the celirosa, a native of Sicily; the coronaria, a native of Italy; and the flos Jovis, a native of Switzerland.

**AGROSTIS**, *bent-grass*, in botany, a genus of the triandria digynia class. The calix has two valves, terminated by a beard or aun. There are fifteen species of the agrostis, eight of which are natives of Britain.

**AGROS-**



- AGROSTOGRAPHIA**, signifies the history or description of grasses.
- AGRYPNIA**, a term with physicians for watching, or an inaptitude to sleep.
- AGUALVA**, in geography, the name of a river of Portugal, and of a town in the island of Tercera.
- AGUAPECACA**, in ornithology, a barbarous name of a species of the tetrao. See **TETRAO**.
- AGUARA-QUIYA**, in botany, a barbarous name of the solanum. See **SOLANUM**.
- AGUARA-PONDA**, in botany, a barbarous name of a species of the viola. See **VIOLA**.
- AGUARICO**, a river of S. America, which, arising in the mountains of Cordeleras, falls into the river of the Amazons.
- AGUBER**, a river of Africa, in the kingdom of Fez, which loses itself in the Beber. See **BEBER**.
- AGUE**, a general name for all kinds of periodical fevers. See **MEDICINE**, title, *Of agues or intermittents*.
- AGUE-tree**, in botany. See **SASSAFRAS**.
- AGUEPERSE**, a town of France, situated in the Lyonnais, about fifteen miles north of Clermont.
- AGUER**, the name of Santa-croix, before it fell into the hands of the Portuguese.
- AGUGLIA**, a name used by some travellers for the obelisks of Egypt. See **OBELISK**.
- AGUIGAN**, one of the Marian islands. See **MARIAN islands**.
- AGUILAR**, a town of Spain, in the province of Navarre, about twenty-four miles west of Estella.
- AGUILAR Del Campo**, a town of Old Castile, with the title of marquisate, about fifteen leagues north of the city of Burgos.
- AGUL**, in botany, a synonyme of the hedyсарum. See **HEDYSARUM**.
- AGURAH**, in Jewish antiquity, the name of a silver coin, otherwise called *gerah*, and *kesbita*.
- AGURANDE**, a fortified town of France, in the country of Berry, about four leagues south of Chartres.
- AGUSADURA**, **AGUSAGE**, in our old customs, a certain fee paid by vassals to their lord, for the sharpening of their plough-tackle.
- AGUTI**, in zoology, the trivial name of a species of the mouse, belonging to the mammalia glires of Linnæus. See **MUS**.
- AGUTI-GUEPA**, in botany. See **SAGITTARIUM**.
- AGUTI-TREVA**, in botany, a barbarous name of a species of the citrus. See **CITRUS**.
- AGUTIGVEPO-OBI**, in botany, a synonyme of the thalia. See **THALIA**.
- AGUZ**, a river of Africa, in the empire of Morocco, and province of Duquela.
- AGWANA**, a kingdom of Africa, upon the golden coast, lying northwards of Aquemboe.
- AGYEI**, in antiquity, a kind of obelisks, sacred to Apollo, erected in the vestibles of houses, by way of security.
- AGYNIANT**, in church-history, a sect of heretics who condemned all carnal commerce with women.
- AGYRTÆ**, in Grecian antiquity, a kind of strolling vagabonds, not unlike our modern gypsies.
- AHÆTULLA**, the trivial name of a species of the coluber, belonging to the order of amphibia serpentes. See **COLUBER**.
- AHALOTH**. See **XYLO-ALOES**.
- AHANIGER**, in zoology. See **ACUS**.
- AHAUSEN**, in geography, the same with Ahuys. See **AHUYS**.
- AHICCYATLI**, in zoology, the Indian name of a serpent resembling the rattle-snake, only it wants the rattles. See **COLUBER**.
- AHMELLA**, in botany. See **BIDENS**.
- AHOUI**, in botany, a synonyme, and also the trivial name of a species of the cerbera. See **CERBERA**.
- AHRENSBOECK**, a fortress of Holstein, on the road from Lubec to Kiel.
- AHUAS**, a considerable town and district of Persia, in the province of Khurestan or Chufistan.
- AHUN**, a town of France, in the higher Marche, situated upon the river Creuse.
- AHUS**, a town of Germany, in the bishoprick of Munster, capital of a considerable district.
- AHUYS**, a sea-port town of Sweden, in the province of Gothland, situated in 32. 14. E. long. and 56. 0. N. lat.
- AIA**, the name of a small river of Italy, which falls into the Tiber, near the village Magliano.
- AIAIA**, in ornithology, a species of the platelea, a bird of the order of grallæ. See **PLATALEA**.
- AJAJOUNI**, the name given by the Turks to a town of Lesser Asia, otherwise called *Hagia*.
- AJAN**, or **AYAN**, the name of a large maritime country of Africa, lying southwards of the mouth of the Red-sea, the natives of which are white.
- AJANTIA**, in antiquity, an annual festival celebrated in the island of Salamis in honour of Ajax.
- AJASALOUÉ**, the modern name by which the Turks call Ephesus. See **EPHESUS**.
- AJAX**, in Grecian antiquity, a kind of dance representing the madness of Ajax after his defeat by Ulysses.
- AJAZZO**, the name of two towns, the one in the island of Corsica; and the other in Lesser Asia, about fifty miles west of Aleppo.
- AICHMALOTARCHA**. See the article **ÆCHMALOTARCHA**.
- AICHSTAT**, a city of Germany in the circle of Franconia, about fourteen miles N. W. of Ingolstat.
- AID**, in a general sense, denotes any kind of assistance given by one person to another.
- AID**, or **AYDE**, in law, denotes a petition made in court to call in help from another person who has interest in land, or any other thing contested.
- AID-de-camp**, in military affairs, an officer employed to receive and carry the orders of a general.
- AID-major**, the French term for an adjutant. See the article **ADJUTANT**.
- AID**, *auxilium*, in ancient customs, a subsidy paid by vassals to their lord on certain occasions.
- Such were the aid of relief, paid upon the death of the Lord Mesne to his heir; the *aid cheval*, or capital

- pital aid, due to the chief lord on several occasions, as, to make his eldest son a knight, to make up a portion for marrying his daughter, &c.
- ROYAL AID**, an appellation sometimes given to the land-tax.
- AIDS**, in the French customs, certain duties paid on all goods exported or imported into that kingdom.
- Court of Aids**, in France, a sovereign court established in several cities, which has cognizance of all causes relating to the taxes, gabels, and aids.
- AIDS**, in the menage, are the same with what some writers call *cherishings*, and used to avoid the necessity of corrections.
- The inner heel, inner leg, inner rein, &c. are called *inner aids*; as the outer heel, outer leg, outer rein, &c. are called *outer aids*.
- AIDS of officers of wood**. See **ASSIZER**.
- AIDINELLI**, or **AIDIN-ILI**, the modern or Turkish name of Natolia, or Lesser Asia. See **NATOLIA**.
- AIELO**, or **AIELLO**, a small town of the kingdom of Naples, in the Farther Abruzzo, with the title of Dutchy.
- AIGHENDALE**, the name of a liquid measure used in Lancashire, containing seven quarts.
- AIGITHALUS**, in ornithology, an obsolete name of the parus or titmouse. See **PARUS**.
- AIGLE**, in geography, the name of a town of France, in the Higher Normandy; also of a promontory in Provence, lying southward of the city of Ciotad; and of a town and district of Switzerland, in the canton of Bern.
- AIGRE**, a river of France, otherwise called *Egre*. See the article **EGRE**.
- AIGLETTE**, in heraldry. See **EAGLET**.
- AIGRETTA**, in ornithology, an obsolete name of the ardea alba. See **ARDEA**.
- AIGUE-marine**. See **AQUA marina**.
- AIGUILLON**, or **EGUILLON**, a small town of France, in the province of Guienne, situated at the conflux of the rivers Garonne and Lot.
- AIGUISCE**, **AIGUISSE**, or **EGUISCE**, in heraldry, denotes a cross with its four ends sharpened, but so as to terminate in obtuse angles.
- It differs from the cross fitchee, in as much as the latter tapers by degrees to a point, and the former only at the ends.
- AILE**, or **AIEL**, in law, a writ which lies where a person's grandfather, or great-grandfather, being seized of lands, &c. in fee simple the day that he died, and a stranger abates or enters the same day, and dispossesses the heir of his inheritance.
- AILESBURY**, the county town of Buckinghamshire, situated near the Thames, about forty-four miles W. of London. It sends two members to parliament, and gives the title of *earl* to the noble family of Bruce. W. long. 16. 55. N. lat. 51. 40.
- AIMARGUES**, a small town of France, in the province of Languedoc, and diocese of Nismes.
- AIN**, a river of France, which, after watering part of Franche Comte and Bresse, falls into the Rhone, about four leagues above Lyons.
- AIPIMIXIRA**, in ichthyology, the American name of a fish called *pudano*.
- AIR**, a thin transparent fluid which encompasses the globe of the earth to a considerable height. For the weight, pressure, elasticity, &c. of air, see **PNEUMATICS**.
- AIR**, in medicine, one of the six non-naturals, and as essential to the life of animals as food, or any of the ordinary evacuations.
- AIR**, in mythology, was adored by the heathens under the names of Jupiter and Juno; the former representing the superior and finer part of the atmosphere, and the latter the inferior and grosser part. The augurs also drew presages from the clouds, thunder, lightning, &c.
- AIR**, in painting, &c. denotes the manner and very life of action; or it is that which expresses the disposition of the agent.
- It is sometimes also used in a somewhat synonymous sense with gesture or attitude.
- AIR**, in music, denotes the melody proper for songs, odes, and the like; being usually quick and lively.
- Sometimes it is used for the songs themselves, called by the Romans *aera*, from which the modern term *air* is derived.
- AIRS**, in the menage, are the artificial motions of taught horses, as the demivolt, curvet, capriole, &c. See **DEMIVOLT**, &c.
- AIR-bladder**, a vesicle in the bodies of most fishes, by which, being filled with air, they are enabled to sink or raise themselves in the water, by compressing or expanding the air contained in this bag, and thereby rendering their bodies at pleasure specifically heavier or lighter than water.
- AIR-gun**, a machine for exploding balls by means of condensed air. See **PNEUMATICS**.
- AIR-pump**, a machine by which the air contained in a proper vessel may be exhausted, or drawn out. See **PNEUMATICS**.
- AIR-shafts**, among miners, are holes made to meet the adits, and supply them with fresh air. These, when the adits are long, or exceeding thirty or forty fathom, become highly necessary, as well to give vent to the damps and noxious vapours, as to let in fresh air.
- AIR-threads**. See **GOSSAMER**.
- AIR-vessels**, are spiral ducts in the leaves, &c. of plants, supposed to be analogous to the lungs of animals, in supplying the different parts of a plant with air.
- AIRA**, in botany, a genus of the triandria digynia class. There are 14 species of the *aira*, nine of which are natives of Britain. The English name is *hair-grass*.
- AIREBA**, in ichthyology, a synonyme of the *raja pallinaca*. See **PASTINACA**.
- AIRANI**, in church-history, a branch of Arians, who, beside the common dogma of that sect, denied the consubstantiality of the Holy Ghost with the Father and Son.
- AIRE**, in geography, a sea-port town in Scotland, situated in 4. 40. W. long. and 55. 30. N. lat. at the

- the mouth of a river of the same name, which discharges itself into the frith of Clyde. Aire is the chief town of the county, and very ancient. About a mile north from the town, there is a lazarus-house, commonly called *the King's chapel*, which King Robert de Bruce set apart for the maintenance of lepers.
- AIRE**, is also the name of two towns of France, the one situated in the province of Gascony, about sixty-five miles S. of Bourdeaux; and the other in Artois, about thirty-five miles S. E. of Calais.
- AIRESHIRE**, a county of Scotland, the capital of which is the town of Aire. It lies eastward of the frith of Clyde.
- AIRING**, a term peculiarly used for the exercising horses in the open air.
- AIRON**, a river of France in the Nivernois.
- AIRONO**, a town of Italy, in the dutchy of Milan.
- AIROU**, a river of France in the province of Normandy.
- AIRY**, or **AERY**, among sportsmen, a term expressing the nest of a hawk or eagle.
- AIRY triplicity**, among astrologers, denotes the three signs, gemini, libra, and aquarius.
- AISE**, in geography. See **AISNE**.
- AISIAMENTA**, in law, the same with easement. See **EASEMENT**.
- AISNE**, or **AISE**, a river of France which rises on the frontiers of Lorraine, near Clermont, and falls into the Oyse, a little below Soissons.
- AITOCZU**, a considerable river of Lesser Asia, which, arising in the mountain Taurus, falls into the south part of the Euxine sea.
- AJUGA**, in botany, a genus of the didynamia gymnospermia class. There are four species of the ajuga, of which the reptans or bugle, and the pyramidalis or mountain bugle, are natives of Britain.
- AJURU-catinga**, in ornithology, the Indian name of a species of the psittacus or parrot. See **PSITTACUS**.
- AJURU-curau**, in ornithology, the Indian name of two species of Brazilian parrots, beautifully variegated with blue, green, red, yellow, and black.
- AJURU-para**, another parrot resembling the ajuru-catinga, but smaller.
- AJUTAGE**, or **ADJUTAGE**, a kind of tube fitted to the mouth of the vessel through which the water of a fountain is to be played. To the different form and structure of ajutages, is owing the great variety of fountains. See **FOUNTAIN**.
- AIX**, in geography, the name of several places, *viz.* of a large city of France, the capital of Provence; of a small town of Savoy, about eight miles N. of Chambery; of an island on the coast of Gascony, between that of Oleron and the main-land; and of a village of Champagne, situated in the generality of Chalons.
- AIX-LA-CHAPELLE**, otherwise called *Aach, Ach,* and *Aken*, an imperial city of Germany, in the dutchy of Juliers. It is large and populous; being much resorted to by foreigners, as well as by the Germans, on account of its hot baths.
- AIZOON**, in botany, a genus of the icosandria pentandria class. The cup is divided into five parts; the flowers consists of one leaf; the capsule or seed-vessel
- has five cells; and the flower-cup rests on the top of the fruit. There are three species of the aizoon, *viz.* the canariense, the hispanicum, and the paniculatum, which last is a native of Africa. This plant resembles the sedum or house-leek.
- AKISSAR**, or **AK-HISSAR**, a town of Lesser Asia, situated upon the river Hermus.
- AKOND**, in the Persian affairs, the chief judge in all cases of contracts and other civil affairs. He is at the head of the lawyers, and has his deputies in all courts of the kingdom.
- AKROCZIM**, a town of Poland, with a castle of considerable strength, situated in the Palatinate of Masovia.
- AKSTADT**, in geography. See the article **AICHSTAT**.
- AL**, an Arabic particle prefixed to words, and signifying much the same with the English particle *the*: Thus they say, alkermes, alkoran, &c. *i. e.* the kermes, the koran, &c.
- AL**, or **ALD**, a Saxon term frequently prefixed to the names of places, denoting their antiquity, as Aldborough, Aldgate, &c.
- ALA**, a Latin term properly signifying a wing; from a resemblance to which several other things are called by the same name: Thus,
- ALA**, in botany, is used in different senses; sometimes it denotes the hollow between the stalk of a plant and the leaves; sometimes it is applied to the two side-petals of the papilionaceous flowers; others use it for the slender membranaceous expansions found in the stems of plants, thence denominated *alated stalks*.
- ALA**, in botany, an obsolete name of the helanium. See **HELENIUM**.
- ALÆ**, in anatomy, a term applied to the lobes of the liver, the cartilages of the nostril, &c.
- ALÆ**, in the Roman art of war, were the two wings or extreme parts of the army drawn up in order of battle.
- ALABA**, in geography, the name of a kingdom of Africa, dependent on the empire of Abyssinia, or Ethiopia, the capital of which is called by the same name.
- ALABASTER**, in natural history, a genus of fossils resembling marble, which are bright, brittle, and do not give fire with steel; they ferment with acids, and readily calcine with heat. There are three species of alabaster; 1. The snow-white shining alabaster, or lygdinum of the ancients, is found in Taurus in pieces large enough to make dishes, or the like. It cuts very freely, and is capable of a fine polish. 2. The yellowish alabaster, or phengites of Pliny, is found in Greece, and is of a soft loose open texture, pretty heavy, and nearly of the colour of honey. This species has likewise been found in Germany, France, and in Derbyshire in England. 3. Variegated, yellow, and reddish alabaster. This species is the common alabaster of the ancients, and is so soft that it may be cut with a knife: It is remarkably bright, and almost transparent; admits of a fine polish, and consists of large angular sparry concretions. It is not proof against water; it ferments violently with aqua-fortis, and

- burns to a pale yellow. The colour of this species is a clear pale yellow resembling amber, and variegated with undulated veins; some of which are pale red, others whitish, and others of a pale brown. It was formerly brought from Egypt, but is now to be met with in several parts of England. The alabasters are frequently used by statuaries for small statues, vases, and columns. After being calcined and mixed with water, they may be cast in any mould like plaster of Paris.
- ALABASTER**, in antiquity, a term not only used for a box of precious ointment; but also for a liquid measure, containing ten ounces of wine, or nine of oil.
- ALABASTRA**, in botany, a name used by the ancients for the calix or cup of flowers.
- ALABASTRUM dendroide**, a kind of laminated alabaster, beautifully variegated with the figures of shrubs, trees, &c.
- ALADINISTS**, a sect among the Mahometans, answering to free-thinkers among us.
- ALADULIA**, in geography, the most easterly division of Lesser Asia, comprehending the ancient Cappadocia, and Armenia Minor.
- ALAGON**, a small town of Spain, in the kingdom of Arragon, situated near the conflux of the river Xalon with the Ebro.
- ALAIS**, a considerable town of France, in the province of Languedoc, situated on the river Gardon, at the foot of the Cevennes.
- ALAISEE**, in heraldry, the same with humetty. See **HUMETTY**.
- ALALCOMENIUS**, in Grecian antiquity, the Bœotian name of the month called, by the Athenians, *Mæmasterion*. See **MÆMACTERION**.
- ALAMIRE**, or *A-LA-MI-RE*, among musicians, a note of the modern scale of music. See **SCALE**.
- ALAMODALITY**, in a general sense, is the accommodating a person's behaviour, dress, and actions to the prevailing taste of the country or times in which he lives.
- ALAMODE**, in commerce, a thin glossy black silk, chiefly used for womens hoods, and mens mourning scarfs.
- ALAN**, a small river of England in the county of Cornwall, which falls into the Bristol channel.
- ALAN**, is also a small town of France, with a very fine castle, situated in the eastern division of Gascony.
- ALANA gelba**, a name by which some writers call the yellowish tripoli. See **TRIPOLI**.
- ALAND**, or **ALANDT**, an island of the Baltic sea, situated between 18. and 20. degrees of long. and between 59. and 61. degrees of lat.
- ALANGUER**, or **ALENGUER**, a town of Portugal, in the province of Estremadura, and about seven leagues from Lisbon.
- ALANORARIUS**, in our old customs, was a keeper of spaniels, setting-dogs, &c. for the use of sportsmen. The word is derived from *alan*, a gothic term for a *grey-hound*.
- ALANTEJO**, in geography. See the article **ALENTEJO**.
- ALAPOULI**, in botany, an obsolete name of a species of the *averrhoa*. See **AVERRHOA**.
- ALAUQUECA**, a stone brought from the E. Indies in small glossy fragments, said to stop hæmorrhages by external application.
- ALARAF**, among Mahometans, denotes the partition-wall which separates heaven from hell.
- ALARBES**, or **ALARABES**, a name given to those Arabians who live in tents, and distinguish themselves by their dress from the others who live in towns.
- ALARES**, in Roman antiquity, an epithet given to the cavalry, on account of their being placed in the two wings of the army.
- ALARES musculi**. See **PTERYGOIDEUS**.
- ALARM**, in the military art, denotes either the apprehension of being suddenly attacked, or the notice thereof, signified by firing a cannon, firelock, or the like. False alarms are frequently made use of to harass the enemy, by keeping them constantly under arms. Sometimes also this method is taken to try the vigilance of the piquet-guard, and what might be expected from them in case of real danger.
- ALARM-bell**, that rung upon any sudden emergency, as a fire, mutiny, or the like.
- ALARM-pass**, or **ALARM-place**, the ground for drawing up each regiment in case of an alarm. This is otherwise called *the rendezvous*.
- ALARM**, in fencing, is the same with what is otherwise called an *appel*, or challenge. See **CHALLENGE**.
- ALATAMAHA**, a large river of N. America, which, rising in the Apalachian mountains, runs south-east through the province of Georgia, and falls into the Atlantic ocean, below the town of Frederica.
- ALATED animals**, such as are furnished with wings.
- ALATED leaves**, in botany, such as are composed of several pinnated ones. See **PINNATED**.
- ALATERNOIDES**, in botany, a synonyme of a species of the myrica. See **MYRICA**.
- ALATERNUS**, in botany, the trivial name of a species of the rhamnus. See **RHAMNUS**.
- ALATRI**, or **ALATRO**, a town of Italy in the Campagna di Roma, situated near the frontiers of Naples.
- ALAVA**, or **ALABRO**, in geography, a territory of Spain, being the south-east division of the province of Biscay.
- ALAUDA**, or **LARK**, in ornithology, a genus of birds of the order of passeræ; the characters of which are these: The beak is cylindrical, subulated, straight; and the two mandibles or chaps are of equal size. The tongue is bifid, and the hinder claw is straight, and longer than the toe. There are nine species of the *alauda*. 1. *Alauda-arvensis*, or common sky-lark, which rises in the air almost perpendicularly, and begins to sing early in the spring, and generally leaves off about midsummer. See Plate III. fig. 2. 2. *Alauda-pratenfis*, or tit-lark, has the two outward feathers of the wing edged with white, and frequents the meadows. 3. The *arborea*, or wood-lark, is a native of Europe, and is distinguished by an annular white fillet about the head. 4. The *campestris*, has one half of its chief feathers of the wings brown, except

- except two in the middle which are white, and the throat and breast are yellowish. 5. The *trivialis*, whose chief feathers on the tail are brown, only half of the outermost is white, and the second is white at the end, in the shape of a wedge; there is likewise a double whitish line on the wings. It is a native of Sweden, and perches on the tops of trees. 6. The *crifata*; the chief tail-feathers are black, but the two outermost are edged with white, and the head is crested. It is a native of Europe. 7. The *spinoletta*, the chief tail-feathers are black, only the outermost two are obliquely half white. It is a native of Italy. 8. The *alpestris*; the chief wing-feathers are half white, the throat yellow, and it has a black streak under the eyes and on the breast. It is a native of N. America. 9.-The *magna*, is yellow on the belly, with a crooked black streak on the breast, and the three side-feathers of the tail white. It is a native of Africa and America.
- ALAUDA marina**, stint, or water-ouzel, in ornithology, an obsolete name of a species of the *sturnus*. See **STURNUS**.
- ALAUDA**, in ichthyology, an obsolete name of a species of the *blennius*. See **BLENNIUS**.
- ALAUSA**, in ichthyology. See **ALOSA**.
- ALAUTA**, a considerable river of Turkey in Europe, which, after watering the north-east part of Transylvania, and part of Wallachia, falls into the Danube almost opposite to Nicopolis.
- ALB**, or **ALBE**, in the Romish church, a vestment of white linen hanging down to their feet, and answering to the surplice of our clergy. In the ancient church, it was usual, with those newly baptized, to wear an alb, or white vestment; and hence the Sunday after easter was called *dominica in albis*, on account of the albs worn by those baptized on easter-day.
- ALB** is also the name of a Turkish coin, otherwise called *asper*. See **ASPER**.
- ALBA firma**, or **ALBUM**, in our old customs, denoted rent paid in silver, and not in corn, which was called *black-mail*.
- ALBA terra**, one of the numerous names for the philosopher's stone.
- ALBAHURIM**, *figura sexdecim laterum*, a figure of great importance according to astrological physicians, who built their prognostics on it.
- ALBANENSES**, in church-history, the same with **Albigenses**. See **ALBIGENSES**.
- ALBANI**, in Roman antiquity, a college of the *salii*, or priests of Mars, so called from mount Albanus the place of their residence. See **SALII**.
- ALBANIA**, a province of Turkey in Europe, situated on the east-side of the gulph of Venice.
- ALBANO**, a town of Italy, in the Campagna di Roma, about twelve miles south-east of Rome, 13. o. E. long. 41. 35. N. lat.
- ALBANS**, or **ST ALBANS**, a town of Hertfordshire, situated about 20 miles north-west of London. It returns two members to parliament, and gives the title of *duke* to the noble family of Beauclerc, 51. 40. N. lat.
- ALBANUM**, a term used by some chemists for salt of urine.
- ALBANY**, a town of N. America, in the province of New-York, situated on Hudson's river, in 74. o. W. long. and 43. o. N. lat.
- ALBARA**, among physicians, a malignant itch, nearly allied to the leprosy.
- ALBARAZIN**, a town of Spain, in the kingdom of Aragon, situated upon the river Guadalavir, about one hundred and ten miles east of Madrid.
- ALBARDEOLA**, in ornithology. See **PLATALEA**.
- ALBARIUM opus**, in Roman antiquity, a kind of plaster made of mere lime, used for covering the ceilings of houses.
- ALBATI equi**, an appellation given to such horses, in the games of the ancient circus, as wore white furniture, in contradistinction from the *veneti*, *prafini*, and *ruffeti*. See **VENETI**, **PRASINI**, &c.
- ALBAZIN**, a town of Greater Tartary, with a strong castle: It is situated upon the river Amur, or Yamour, in 54. o. of N. lat. and belongs to the Muscovites.
- ALBE**, a small piece of money, current in Germany, worth only a French sol and seven deniers.
- ALBELLUS**, in ornithology, the trivial name of a species of the *mergus*. See **MERGUS**.
- ALBEMARLE**, a town of France, in the province of Normandy, from whence the noble family of Keppel takes the title of earl, in 2. o. E. long. 49. 45. N. lat.
- ALBEMARLE** is also the name of the most northerly district of N. Carolina. See **CAROLINA**.
- ALBENGA**, a sea-port town of Italy situated on the Mediterranean, about fifteen miles north-east of Oneglia.
- ALBERTUS**, a gold coin, worth about fourteen French livres: it was coined during the administration of Albertus archduke of Austria.
- ALBESIA**, in antiquity, a kind of shields otherwise called *decumana*. See **DECUMANA**.
- ALBICILLA**, in ornithology, the trivial name of a species of the *falco*. See **FALCO**.
- ALBIGENSES**, in church-history, a sect of Christians which appeared in the 12th and 13th centuries. They are ranked among the grossest heretics, the Manicheans, by Roman Catholics; from which charge Protestants generally acquit them, though with some limitation. See **MANICHEANS**.
- At the time of the Reformation, those of the **Albigenses** who remained embraced Calvinism.
- ALBIGENSES** is also a name sometimes, though improperly, used for a sect more usually known by that of *Waldenses*. See **WALDENSES**.
- ALBIGEOIS**, a small district of France in the higher Languedoc, containing the dioceses of Albi and Castres.
- ALBII**, in church-history, the same with **Albigenses**. See **ALBIGENSES**.
- ALBINOS**, the name by which the Portuguese call the white Moors, who are looked upon by the negroes as monsters. They are the issue of a white man and black woman, and at a distance might be taken for Europeans; but, when you come near them, their white

- white colour appears like that of persons affected with a leprosy.
- ALBION**, the ancient name of Britain. See **BRITAIN**.  
*New ALBION*, a name given by Sir Francis Drake to California. See **CALIFORNIA**.
- ALBLASSERWAERT**, a district of South Holland, lying eastward of Dort, between the rivers Meuse and Leck.
- ALBOGALERUS**, in Roman antiquity, a white cap worn by the *flamen dialis*, on the top of which was an ornament of olive branches.
- ALBONA**, **ALBONO**, or **ALBOGNA**, a river of Italy in the dutchy of Milan, which waters the Novaresa and district of Laumello.
- ALBORAK**, amongst the Mahometan writers, the beast on which Mahomet rode, in his journeys to heaven.
- ALBORAN**, a small island of Africa, lying on the coast of the kingdom of Fez.
- ALBOURG**, or **ALBURG**, a sea-port town of N. Jutland, in the kingdom of Denmark.
- ALBRET**, or **ALBRIT**, a small town of France, in the province of Gascony, about thirty-five miles S. of Bourdeaux.
- ALBUCA**, in botany, a genus of the hexandria monogynia class. There are only two species of this plant, *viz.* the major, with lanceolated leaves; and minor, with subulated leaves; both natives of the Cape of Good Hope.
- ALBUCUS**, in botany, an obsolete name of a species of asphodelus.
- ALBUGINEA tunica**, in anatomy, the third or innermost coat or covering of the testes; it is likewise the name given to one of the coats of the eye. See **ANATOMY**, Part VI.
- ALBUGINEUS**, in anatomy, a term sometimes applied to the aqueous humour of the eye.
- ALBUGO**, in medicine, a distemper occasioned by a white opaque spot growing on the *cornea* of the eye, and obstructing vision.
- ALBULA**, in ichthyology, the trivial name of a species of the salmo. See **SALMO**.
- ALBULA indica**, in ichthyology, an obsolete name of the salmo bimaculatus. See **SALMO**.
- ALBUM**, in antiquity, a kind of table, or register, wherein the names of certain magistrates, public transactions, &c. were entered. Of these there were various sorts; as the *album senatorum*, *album judicum*, *album pratoris*, &c.
- ALBUM**. See **ALBUMEN**, **CERVUS**.
- ALBUM gracum**, among physicians, the white dung of dogs, formerly prescribed for inflammations of the throat, &c. but now justly despised.
- ALBUM nigrum**, a term for mice-dung.
- ALBUM oculi**, the white of the eye. See **ALBUGINEA**, **ADNATA**.
- ALBUMEN**, among physicians, the white of an egg. See **EGG**.
- ALBUQUERQUE**, a city of Spain, in the kingdom of Leon and province of Estremadura, situated on the frontiers of Portugal, 7. 0. W. long. 30. 0. N. lat.
- ALBURN**, the English name of a compound colour, being a mixture of white and red, or reddish brown.
- ALBURNUM**, that part of the wood which is next the bark of trees.
- ALBURNUS**, in ichthyology, the trivial name of a species of the Cyprinus. See **CYPRINUS**.
- ALBURNUS lacustris**, an obsolete name of the cyprinus ballerus. See **CYPRINUS**.
- ALBUS piscis**, an obsolete name of the cyprinus grislagine. See **CYPRINUS**.
- ALBY**, or **ALBI**, a city of France in the province of Languedoc, situated in 0. 40. E. long. and 43. 50. N. lat.
- ALCA**, in ornithology, a genus of the order of anferes. The beak of this genus is without teeth, short, convex, compressed, and frequently furrowed transversely; the inferior mandible is gibbous near the base; the feet have generally three toes. The species of the alca are six. 1. The tordo, or razor-bill, with four furrows on the bill, and a white line on each side running from the bill to the eyes. Great numbers of them hatch together in the caverns of rocks, and lay but one egg at a time. 2. The impennis, or northern penguin, with a compressed bill furrowed on each side, and an oval spot on each side of the eyes. 3. The arctica, or puffin, with a compressed bill and four furrows; the orbit of the eyes and temples are white. 4. The lomvia, or seahen, with a smooth oblong bill, and the upper mandible yellow on the edges. 5. The grylle, or Greenland dove, with a smooth subulated bill, and a large white spot on the belly and wings; the feet are red. 6. The alle, or black and white diver, with a smooth conical bill, a white streak on the belly and wings, and black feet. All the species of this genus frequent the northern shores of Europe.
- ALCACER de Sal**, or **ALCAREZ**, a town of Portugal in the province of Estremadura, about forty-five miles south-east of Lisbon; 9. 0. W. long. 38. 30. N. lat.
- ALCAICS**, in ancient poetry, a denomination given to several kinds of verse, from the inventor Alcaeus.
- ALCAID**, **ALCAÏDE**, or **ALCALDE**, in the polity of the Moors, Spaniards, and Portuguese, a magistrate, or officer of justice, answering nearly to the French provost, and the British justice of peace.—The alcaid among the Moors is vested with supreme jurisdiction, both in civil and criminal cases.
- ALCALA de Guadiara**, a town of Spain in the province of Andalusia, about six miles S. of Seville.
- ALCALA de Henares**, a town of Spain, in the province of New Castile, about sixteen miles E. of Madrid.
- ALCALA de Real**, a city of Spain, in the province of Andalusia, about fifteen miles north-west of the city of Granada.
- ALCALY**. See **ALKALI**.
- ALCANITZ**, a small town of Spain, in the kingdom of Arragon, situated on the river Guadaloupe.
- ALCANNA**, in commerce, a powder prepared from the leaves of the Egyptian privet, in which the people of Cairo drive a considerable trade. It is much used by the Turkish women, to give a golden colour to their



Fig. 1. ALCA or  
Razor bill.

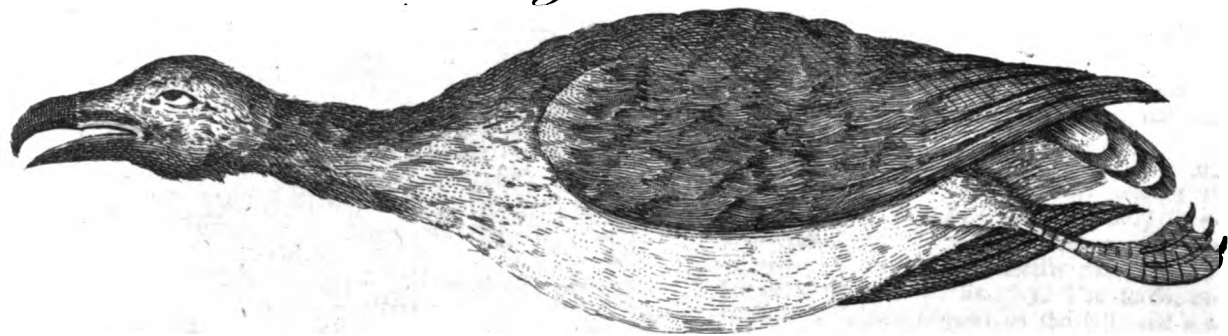


Fig. 2. ALCEDO or  
King's Fisher.





their nails and hair. In dying, it gives a yellow colour, when steeped with common water; and a red one, when infused in vinegar. There is also an oil extracted from the berries of alcanna, and used in medicine as a calmer.

**ALCANNA.** See **ICHTHYOCOLLA.**

**ALCANTARA**, a city of Spain, in the province of Estremadura, on the frontiers of Portugal; 7. o. W. long. 39. 10. N. lat.

*Knights of ALCANTARA*, a military order of Spain, which took its name from the above-mentioned city.

The knights of Alcantara make a very considerable figure in the history of the expeditions against the Moors.

**ALCARAZ**, a town of Spain, in the province of New-Castile, situated on the river Guadarema; 3. o. W. long. 38. 3. N. lat.

**ALCAZAR de Sal**, a small town of Portugal, in the province of Estremadura, near the confines of that of Alentejo.

**ALCE**, or **ALCES**, in zoology, the trivial name of a species of the cervus, belonging to the order of mammalia pecora. See **CERVUS.**

**ALCEA**, or **VERVAIN-MALLOW**, in botany, a genus of the monodelphia polyandria class. There are only two species of this genus, *viz.* the rosea and ficifolia. This genus differs little from the common mallow, either in figure or medical virtues, excepting that the leaves of the alcea are more deeply divided.

**ALCEA vesicaria**, in botany, an obsolete name of a species of the ketmia. See **KETMIA.**

**ALCEDO**, or the **KINGS-FISHER**, in ornithology, a genus of the order of picæ. The alcedo has a long, straight, thick, triangular bill; with a fleshy, plain, short, flat tongue. There are seven species of the alcedo, *viz.* 1. The *ispida*, or common kings-fisher, with a short tail, blue above, and yellowish below. It haunts the shores of Europe and Asia. 2. The *erithaca*, with a short tail, a blue back, a yellow bill, a purple head and rump, and the throat and opposite part of the neck white. It is a native of Bengal. 3. The *alcyon*, with a short black tail, white belly, and ferruginous breast. It is a native of America. 4. The *todus*, with a short green tail, a blood-coloured throat, and a white belly. It is a native of America; and is the green sparrow, or green humming-bird of Edwards. 5. The *smyrnenis*, with a short green tail, ferruginous wings, and green back. It is a native of Africa and Asia. 6. The *rudis*, with a brown short tail variegated with white. It is a native of Persia and Egypt. 7. The *dea*, with two very long feathers in the tail, a blackish blue body, and greenish wings. It is a native of Surinam. All the species of this genus dive in the water, and catch fish with their long beaks.

**ALCHEMILLA**, or **LADIES-MANTLE**, a genus of the tetrandria monogynia class. The leaves of this genus are serrated. The cup is divided into eight segments; the flowers are apetalous, and collected in bunches at the top of the stalk; the seed-capsules general-

ly contain two conic seeds in each. There are only three species of the alchemilla, *viz.* the vulgaris of the shops, which is esteemed a powerful vulnerary; the minor, or least ladies-mantle; and the alpina, or cinque-foil ladies-mantle; all of which are natives of Britain.

**ALCHEMIST**, a practitioner in alchemy. See **ALCHEMY.**

**ALCHEMY**, that branch of chemistry which had for its principal objects the transmutation of metals into gold; the panacea, or universal remedy; an alkahest, or universal menstruum; an universal ferment; and many other things equally ridiculous. See **CHEMISTRY, Introduction.**

**ALCHEMY** is also sometimes used as a synonymous term for chemistry in general.

**ALCHIMILLA.** See **ALCHEMILLA.**

**ALCHIMY**, **ALCHYMY**, and **ALCHYMIST.** See **ALCHEMY**, and **ALCHEMIST.**

**ALCHITRAM**, or **ALCHITRAN**, a term among alchemists for the oil of juniper, &c.

**ALCIBIUM**, or **ALCIBIADUM**, in botany, an obsolete term of a species of echium. See **ECHIUM.**

**ALCMAER**, a town of N. Holland, remarkable for the fine pastures in its neighbourhood, and the great quantities of butter and cheese made there.

**ALCMANIAN**, in ancient lyric poetry, a kind of verse consisting of two dactyles and two trochees; as,

*Virginibus puerisque | canto.*

**ALCOA arbor**, the name of a tree in St Helena, said to emulate ebony.

**ALCOBACO**, a small town of Portugal, in the province of Estremadura: It is defended by a pretty strong castle; but what makes it most remarkable, is the abbey of St Bennet, which is the burying-place of most of the kings of Portugal.

**ALCOHOL**, or **ALKOOL**, in chemistry, spirit of wine highly rectified. It is also used for any highly rectified spirit.—Alcohol is extremely light and inflammable: It is a strong antiseptic, and therefore employed to preserve animal substances. For the other qualities of alcohol, see **CHEMISTRY.**

**ALCOHOL** is also used for any fine impalpable powder.

**ALCOHOLIZATION**, among chemists, the process of rectifying any spirit. It is also used for pulverization.

**ALCOLA**, a term among chemists for the tartar of urine.

**ALCORAN**, or **ALKORAN**, the name of a book held equally sacred among the Mahometans, as the Bible is among Christians.

The word *alkoran* properly signifies *reading*; a title given it by way of eminence, just as we call the Old and New Testaments *Scriptures*. See **MAHOMETANISM.**

**ALCORAN**, in a figurative sense, is an appellation given to any books full of impostures or impiety.

**ALCORAN**, among the Persians, is also used for a narrow kind of steeple, with two or three galleries, where

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- the priests, called Moravites, say prayers with a loud voice.
- ALCORANISTS**, among the Mahometans, an appellation given to those who adhere closely to the alcoran as the ultimate rule of faith: Such are the Persians, in contradistinction from the Turks, Arabs, &c. who admit a multitude of traditions besides the alcoran.
- ALCOST**, an obsolete name of a species of tansey.
- ALCOVE**, among builders, a recess, or part of a chamber separated by an eltrade, or partition of columns, and other corresponding ornaments, in which is placed a bed of state, and sometimes seats to entertain company.
- These alcoves are frequent in Spain, and the bed raised two or three ascents, with a rail at the foot.
- ALCOYTIN**, a small town of Portugal, in the province of Algarva, defended by one of the strongest castles in that kingdom.
- ALCYON**, the trivial name of a species of alcedo. See **ALCEDO**.
- ALCYONIUM**, in obsolete name of a submarine plant. It is also used for a kind of coral, or alstroites, frequently found fossil in England.
- ALDABARAM**, in anatomy. See **SESAMOIDEA**.
- ALDARU**, in botany, an obsolete name of a species of pistachia. See **PISTACHIA**.
- ALDBOROUGH**, a sea-port town of Suffolk, which sends two members to parliament; 1. 40. E. long. 52. 20. N. lat.
- ALDBOROUGH**, is also a market-town of Yorkshire, about fifteen miles north-west of the city of York.
- ALDEA**, a town of Portugal, in the province of Estremadura, about ten miles S. of Lisbon.
- ALDEBAC**, the Arabian term for bird-lime.
- ALDEBARAN**, in astronomy, a star of the first magnitude, called, in English, the bull's eye, as making the eye of the constellation Taurus.
- ALDEGO**, a river of Italy, in the territories of Venice, which loses itself in the Adige.
- ALDENAER**, a small town of Germany in the electorate of Cologne, situated on the river Aar.
- ALDENBURG**. See **ALTENBURG**.
- ALDER-tree**, in botany. See **BETULA**.
- ALDERMAN**, in the British policy, a magistrate subordinate to the lord-mayor of a city or town-corporate.
- The number of these magistrates is not limited, but is more or less according to the magnitude of the place. In London they are twenty-six; each having one of the wards of the city committed to his care. This office is for life; so that when one of them dies, or resigns, a ward-mote is called, who return two persons, one of whom the lord-mayor and aldermen chuse to supply the vacancy. By the charter of the city of London, all the aldermen who have been lord-mayors, together with the three eldest ones not arrived at that dignity, are justices of the peace.
- ALDERMAN**, among our Saxon ancestors, was a degree of nobility answering to earl or count at present.
- ALDERMAN** was also used, in the time of king Edgar, for a judge or justice; in-which sense Alwin is called *aldermannus totius Anglia*.
- ALDERNEY**, or **AURIGNI**, an island on the coast of Normandy, subject to the crown of Great Britain.
- ALDII**, an appellation given to those servants who attended their masters to the wars.
- ALDROVANDA**, in botany, a genus of the pentandria pentagynia class; of which there is but one species. The calix is divided into five parts; the petals are five; and the capsule has five valves, with ten seeds. It is a native of Italy and the Indies.
- ALE**, a fermented liquor, obtained from an infusion of malt; and differing only from beer in having a less proportion of hops. See **BREWING**.
- Ale is thought to be the same kind of liquor with the cerevisia, zythum, and curmi of the ancients.
- Medicated ALES**, those wherein medicinal herbs have been infused, or put to ferment: Such are the cerevisia cephalica, cerevisia epileptica, &c.
- ALE-berry**, the popular name for ale that is boiled with bread and mace, sweetened, strained, and drunk hot.
- ALE-connor**, an officer in London who inspects the measures of public houses. They are four in number, and chosen by the common-hall of the city.
- ALE-silver**, a tax paid yearly to the lord-mayor, by all who sell ale within the city.
- ALE-measure**. See **MEASURE**.
- ALEA**, in Roman antiquity, denotes in general all manner of games of chance; but, in a more restricted sense, was used for a particular game played with dice and tables, not unlike our backgammon. See **BACKGAMMON**.
- ALEATORIUM**, a place in the ancient gymnasia, where they played at the aleæ.
- ALEC**, in ichthyology, an obsolete name a species of SPARUS. See **SPARUS**.
- ALECAST**. See **ALCAST**.
- ALECTORIA**, a stone said to be formed in the gall-bladders of old cocks, to which the ancients ascribed many fabulous virtues.
- ALECTORICARDITES**, the name of a stone resembling a pullet's head.
- ALECTORIUS lapis**. See **ALECTORIA**.
- ALECTOROMANTIA**, in Grecian antiquity, a species of divination performed by means of a cock; in the following manner: A circle being described on the ground, and divided into twenty-four equal portions, in each of these spaces was written one of the letters of the alphabet, and on each of the letters was laid a grain of wheat; after which a cock being turned loose in the circle, particular notice was taken of the grain picked up by the cock, because the letters under them, being formed into a word, made the answer desired.
- ALEAGAR**, or **ALEGER**, the name of a kind of vinegar made of ale instead of wine.
- ALEGRETTE**, a town of Portugal, in the province of Alantejo, situated on the river Caya; 7. 50. W. long. 39. 0. N. lat.
- ALEIPHA**, among ancient physicians, the name of animal or vegetable oils, when used as unguents.
- ALEMBIC**, in chemistry. See **CHEMISTRY**.
- ALEMBROTH**, an obsolete name of a kind of fixed alkaline salt.

ALENGNER,

**ALENGNER**, a town of Portugal, in the province of Estremadura, about twenty-seven miles N. E. of Lisbon.

**ALENON salt**, an obsolete name of the oil of almonds.

**ALENTEJO**, a province of Portugal, lying southward of Tagus.

**ALENZON**, a strong city of Normandy, situated under the same meridian with London, in 48. 32. N. lat. It is the capital of the dutchy of the same name.

**ALEORE**, among ancient physicians, denoted the intervals of ease that alternately succeed acute pains.

**ALEPPO**, a large city of Asiatic Turkey, situated in E. long. 37. 4. and N. lat. 36. 30.

It is an inland town, lying almost in the middle between the river Euphrates and the Levant sea. The Christians, who are allowed the free exercise of their religion, have their houses and churches in the suburbs. The beglerbeg of Aleppo commands the whole extent of country, between the Levant-sea and the Euphrates.

**ALERION**, or **ALLERION**, in heraldry. See **ALLERION**.

**ALESSANO**, a town of the kingdom of Naples, situated about twelve miles west of the city Otranto.

**ALESSIO**, a town of European Turkey, in the province of Albania, situated near the mouth of the river Drimo.

**ALET**, or **ALETH**, a city of France, situated in the Upper Languedoc, at the foot of the Pyrennees, about thirty-two miles south-west of Narbonne, 2. 0. E. long. 43. 10. N. lat.

**ALETRIS**, in botany, a genus of the hexandria monogynia class. The corolla is tunnel-shaped, the stamina are inserted into the base of the petals; and the capsule consists of three cells. There are only three species of the aletris, viz. the farinosa, a native of America; the capensis, a native of the Cape of Good Hope; and the fragrans, a native of Africa. The two first are perennial plants, and the last is a fruit-bearing shrub. These are all ranked among the aloes of different authors. See **ALOE**.

**ALEUROMANCY**, a species of divination performed by means of meal or flour.

**ALEXANDERS**, in botany. See **SMYRNIUM**.

**ALEXANDRETFA**, in geography, the same with Scanderoon. See the article **SCANDEROON**.

**ALEXANDRIA**, a sea-port town of Egypt, situated in 31. 15. E. long. and 30. 40. N. lat. about fourteen miles westward of the most westerly branch of the river Nile.

**ALEXANDRIA** is also the name of a city of Italy, situated on the river Tanaro, about forty miles N. W. of Genoa, 8. 52. E. long. 44. 45. N. lat.

**ALEXANDRIAN**, or **ALEXANDRIN**, in poetry, a kind of verse, consisting of twelve, or of twelve and thirteen syllables alternately; so called from a poem on the life of Alexander, written in this kind of verse by some French poet.

Alexandrines are peculiar to modern poetry, and seem well adapted to epic poems. They are sometimes used by most nations of Europe, but chiefly by the French, whose tragedies are generally composed of Alexandrines.

**ALEXANDRINUM**, the name of a plaster described by Celsus.

**ALEXICACUS**. See **ALEXETERIAL**.

**ALEXICACUS** was also a name under which the fishermen used to invoke Neptune, to preserve their nets from being torn to pieces by the sword-fish.

**ALEXIPHARMICS**, among physicians, properly signify medicines which correct or expel poison.

**ALEXITERIAL**. See the last article.

**ALFAQUES**; among the Moors, the name generally used for their clergy, or those who teach the Mahometan religion, in opposition to the Morabites, who answer to monks among Christians.

**ALFELD**, a town of Germany, in the bishoprick of Hildesheim, and circle of Lower Saxony, situated about ten miles S. of Hildesheim, in 9. 50. E. long. and 52. 0. N. lat.

**ALFET**, in our old customs, denotes a caldron full of boiling water, wherein an accused person, by way of trial or purgation, plunged his arm up to the elbow.

**ALGA**, in botany, the trivial name of the lichen, fungus, and several other plants of the cryptogamia class.

**ALGAROT**, in chemistry, an Arabic term for an emetic powder, prepared from regulus of antimony, dissolved in acids, and separated by repeated lotions in warm water.

**ALGARVA**, the most southerly province of the kingdom of Portugal.

## A L G E B R A.

**ALGEBRA** is a general method of computation by certain signs and symbols, which have been contrived for this purpose, and found convenient. It is called an **UNIVERSAL ARITHMETIC**, and proceeds by operations and rules similar to those in common arithmetic, founded upon the same principles. But as a number of symbols are admitted into this science, being

necessary for giving it that extent and generality which is its greatest excellence, the import of those symbols must be clearly stated.

In geometry, lines are represented by a line, triangles by a triangle, and other figures by a figure of the same kind: But, in algebra, quantities are represented by the same letters of the alphabet; and various signs have been

been imagined for representing their affections, relations, and dependencies.

The relation of equality is expressed by the sign  $=$ ; thus, to express that the quantity represented by  $a$  is equal to that which is represented by  $b$ , we write  $a = b$ . But if we would express that  $a$  is greater than  $b$ , we write  $a > b$ ; and if we would express algebraically that  $a$  is less than  $b$ , we write  $a < b$ .

QUANTITY is what is made up of parts, or is capable of being greater or less. It is increased by *addition*, and diminished by *subtraction*; which are therefore the two primary operations that relate to quantity. Hence it is, that any quantity may be supposed to enter into algebraic computations two different ways, which have contrary effects; either as an *increment*, or as a *decrement*; that is, as a quantity to be added, or as a quantity to be subtracted. The sign  $+$  (*plus*) is the mark of *addition*, and the sign  $-$  (*minus*) of *subtraction*. Thus the quantity being represented by  $a$ ,  $+a$  imports that  $a$  is to be added, or represents an increment; but,  $-a$  imports that  $a$  is to be subtracted, and represents a decrement. When several such quantities are joined, the signs serve to shew which are to be added and which are to be subtracted. Thus  $+a + b$  denotes the quantity that arises when  $a$  and  $b$  are both considered as increments, and therefore expresses the sum of  $a$  and  $b$ . But  $+a - b$  denotes the quantity that arises, when from the quantity  $a$  the quantity  $b$  is subtracted; and expresses the excess of  $a$  above  $b$ . When  $a$  is greater than  $b$ , then  $a - b$  is itself an increment; when  $a = b$ , then  $a - b = 0$ ; and when  $a$  is less than  $b$ , then  $a - b$  is itself a decrement.

As addition and subtraction are opposite, or an increment is opposite to a decrement, there is an analogous opposition between the affections of quantities that are considered in the mathematical sciences; as, between excess and defect; between the value of effects or money due to a man, and money due by him. When two quantities, equal in respect of magnitude, but of those opposite kinds, are joined together, and conceived to take place in the same subject, they destroy each other's effect, and their amount is *nothing*. Thus, 100 *l.* due to a man and 100 *l.* due by him balance each other, and in estimating his stock may be both neglected. When two unequal quantities of those opposite qualities are joined in the same subject, the greater prevails by their difference. And, when a greater quantity is taken from a lesser of the same kind, the remainder becomes of the opposite kind.

A quantity that is to be added is likewise called a *positive* quantity; and a quantity to be subtracted is said to be *negative*: They are equally real, but opposite to each other, so as to take away each other's effect, in any operation, when they are equal as to quantity. Thus,  $3 - 3 = 0$ , and  $a - a = 0$ . But though  $+a$  and  $-a$  are equal as to quantity, we do not suppose in algebra that  $+a = -a$ ; because, to infer equality in this science, they must not only be equal as to quantity, but of the same quality, that in every operation the one may have the same effect as the other. A decrement may be equal to an increment, but it has in all operations a contrary effect; a motion downwards may be equal to a mo-

tion upwards; and the depression of a star below the horizon may be equal to the elevation of a star above it: But those positions are opposite, and the distance of the stars is greater than if one of them was at the horizon, so as to have no elevation above it, or depression below it. It is on account of this contrariety, that a negative quantity is said to be less than nothing, because it is opposite to the positive, and diminishes it when joined to it; whereas the addition of 0 has no effect. But a negative is to be considered no less as a real quantity than the positive. Quantities that have no sign prefixed to them are understood to be positive.

The number prefixed to a letter is called the numeral *coefficient*, and shews how often the quantity represented by the letter is to be taken. Thus  $2a$  imports that the quantity represented by  $a$  is to be taken twice;  $3a$  that it is to be taken thrice; and so on. When no number is prefixed, *unit* is understood to be the coefficient. Thus 1 is the coefficient of  $a$  or of  $b$ .

Quantities are said to be *like* or *similar*, that are represented by the same letter or letters equally repeated. Thus  $+3a$  and  $-5a$  are like; but  $a$  and  $b$ , or  $a$  and  $a^2$  are unlike.

A quantity is said to consist of as many terms as there are parts joined by the signs  $+$  or  $-$ ; thus  $a + b$  consists of two terms, and is called a *binomial*;  $a + b + c$  consists of three terms, and is called a *trinomial*. These are called *compound* quantities: A *simple* quantity consists of one term only, as  $+a$ , or  $+ab$ , or  $+abc$ .

## CHAP. I. Of ADDITION.

CASE I. To add quantities that are like, and have like signs.

RULE. Add together the coefficients, to their sum prefix the common sign, and subjoin the common letter or letters.

EXAMPLE. To  $+5a$  to  $-6b$  to  $a+b$   
 Add  $+4a$  add  $-2b$  add  $3a+5b$   
 Sum  $+9a$  Sum  $-8b$  Sum  $4a+6b$

CASE II. To add quantities that are like, but have unlike signs.

RULE. Subtract the lesser coefficient from the greater, prefix the sign of the greater to the remainder, and subjoin the common letter or letters.

EXAMP. To  $-4a$  |  $+5b-6c$   
 Add  $+7a$  |  $-3b+8c$   
 Sum  $+3a$  |  $2b+2c$

This rule is easily deduced from the nature of positive and negative quantities.

If there are more than two quantities to be added together, first add the positive together into one sum, and then the negative (by Case I.); then add these two sums together (by Case II.)

CASE

**CASE III.** To add quantities that are unlike.

**RULE.** Set them all down one after another, with their signs and coefficients prefixed.

EXAMPLE. To	$+ 2 a$	$+ 3 a$
	$+$ Add $+ 3 b$	$- 4 x$
	Sum $2 a + 3 b$	$3 a - 4 x$

### CHAP. II. OF SUBTRACTION.

**GENERAL RULE.** "Change the signs of the quantity to be subtracted into their contrary signs, and then add it so changed to the quantity from which it was to be subtracted, (by the rules of the last chapter): the sum arising by this addition is the remainder." For, to subtract any quantity, either positive or negative, is the same as to add the opposite kind.

EXAMP. From	$+ 5 a$	$8 a - 7 b$
	Subtract $+ 3 a$	$3 a + 4 b$
	Remaind. $5 a - 3 a$ , or $2 a$	$5 a - 11 b$

It is evident, that to subtract or take away a decrement is the same as adding an equal increment. If we take away  $- b$  from  $a - b$ , there remains  $a$ ; and if we add  $+ b$  to  $a - b$ , the sum is likewise  $a$ . In general, the subtraction of a negative quantity is equivalent to adding its positive value.

### CHAP. III. Of MULTIPLICATION.

**IN MULTIPLICATION**, the general rule for the signs is, That when the signs of the factors are like, (i. e. both  $+$ , or both  $-$ ), the sign of the product is  $+$ ; but when the signs of the factors are unlike, the sign of the product is  $-$ .

**CASE I.** When any positive quantity,  $+ a$ , is multiplied by any positive number,  $+ n$ , the meaning is, That  $+ a$  is to be taken as many times as there are units in  $n$ ; and the product is evidently  $n a$ .

**CASE II.** When  $- a$  is multiplied by  $n$ , then  $- a$  is to be taken as often as there are units in  $n$ , and the product must be  $- n a$ .

**CASE III.** Multiplication by a positive number implies a repeated addition: But multiplication by a negative implies a repeated subtraction. And when  $+ a$  is to be multiplied by  $- n$ , the meaning is, That  $+ a$  is to be subtracted as often as there are units in  $n$ : Therefore the product is negative, being  $- n a$ .

**CASE IV.** When  $- a$  is to be multiplied by  $- n$ , then  $- a$  is to be subtracted as often as there are units in  $n$ ; but (by chap. II.) to subtract  $- a$  is equivalent to adding  $+ a$ , consequently the product is  $+ n a$ .

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The II<sup>d</sup> and IV<sup>th</sup> Cases may be illustrated in the following manner.

By the definitions,  $+ a - a = 0$ ; therefore if we multiply  $+ a - a$  by  $n$ , the product must vanish, or be 0, because the factor  $a - a$  is 0. The first term of the product is  $+ n a$  (by Case I.) Therefore the second term of the product must be  $- n a$ , which destroys  $+ n a$ ; so that the whole product must be  $+ n a - n a = 0$ . Therefore  $- a$  multiplied by  $+ n$  gives  $- n a$ .

In like manner, if we multiply  $+ a - a$  by  $- n$ , the first term of the product being  $- n a$ , the latter term of the product must be  $+ n a$ ; because the two together must destroy each other, or their amount be 0, since one of the factors (viz.  $a - a$ ) is 0. Therefore  $- a$  multiplied by  $- n$ , must give  $+ n a$ .

In this general doctrine, the multiplier is always considered as a number. A quantity of any kind may be multiplied by a number.

If the quantities to be multiplied are simple quantities, "find the sign of the product by the last rule; after it place the product of the coefficients, and then set down all the letters after one another as in one word."

EXAMP. Mult.	$+ a$	$- 2 a$	$6 x$
	By	$+ 4 b$	$- 5 a$
	Prod.	$+ 4 a b$	$- 30 a x$
	Mult.	$- 8 x$	$+ 3 a b$
	By	$- 4 a$	$- 5 a c$
	Prod.	$+ 32 a x$	$- 15 a a b c$

To multiply compound quantities, you must "multiply every part of the multiplicand by all the parts of the multiplier, taken one after another, and then collect all the products into one sum: That sum shall be the product required."

EXAMP. Mult.	$a + b$	$2 a - 3 b$								
	By	$a + b$								
	Prod.	<table style="border-collapse: collapse; margin: 0 auto;"> <tr> <td style="padding-right: 5px;">{</td> <td style="padding-right: 5px;"><math>a a + a b</math></td> <td style="padding-right: 5px;">{</td> <td style="padding-right: 5px;"><math>8 a a - 12 a b</math></td> </tr> <tr> <td></td> <td style="padding-right: 5px;"><math>+ a b + b b</math></td> <td></td> <td style="padding-right: 5px;"><math>+ 10 a b - 15 b b</math></td> </tr> </table>	{	$a a + a b$	{	$8 a a - 12 a b$		$+ a b + b b$		$+ 10 a b - 15 b b$
{	$a a + a b$	{	$8 a a - 12 a b$							
	$+ a b + b b$		$+ 10 a b - 15 b b$							
	Sum	$a a + 2 a b + b b$								
	Mult.	$a a + a b + b b$								
	By	$a - b$								
	Prod.	<table style="border-collapse: collapse; margin: 0 auto;"> <tr> <td style="padding-right: 5px;">{</td> <td style="padding-right: 5px;"><math>a a a + a a b + a b b</math></td> </tr> <tr> <td></td> <td style="padding-right: 5px;"><math>- a a b - a b b - b b b</math></td> </tr> </table>	{	$a a a + a a b + a b b$		$- a a b - a b b - b b b$				
{	$a a a + a a b + a b b$									
	$- a a b - a b b - b b b$									
	Sum	$a a a . . . 0 . . . 0 . . . - b b b$								

Products that arise from the multiplication of two, three, or more quantities, as  $a b c$ , are said to be of two, three, or more dimensions; and those quantities are called *factors* or *roots*.

If all the factors are equal, then these products are called *powers*; as  $a a$ , or  $a a a$ , are powers of  $a$ . Powers are expressed sometimes by placing above the

+ X root,

root, to the right hand, a figure expressing the number of factors that produce them. Thus,

$a$   
 $aa$   
 $aaa$   
 $aaaa$   
 $aaaaa$

is called the

1st  
 2d  
 3d  
 4th  
 5th

Power of the root  $a$ , and is shortly expressed thus,

$a^2$   
 $a^3$   
 $a^4$   
 $a^5$

These figures which express the number of factors that produce powers, are called their *indices* or *exponents*; thus 2 is the index of  $a^2$ . And *powers of the same root are multiplied by adding their exponents*. Thus  $a^2 \times a^3 = a^5$ .  $a^4 \times a^3 = a^7$ .  $a^3 \times a = a^4$ .

Sometimes it is useful not actually to multiply compound quantities, but to set them down with the sign of multiplication ( $\times$ ) between them, drawing a line over each of the compound factors. Thus  $a + b \times a - b$  expresses the product of  $a + b$ , multiplied by  $a - b$ .

CHAP. IV. Of DIVISION.

THE same rule for the signs is to be observed in division as in multiplication; that is, "If the signs of the dividend and divisor are like, the sign of the quotient must be +; if they are unlike, the sign of the quotient must be -." This will be easily deduced from the rule in multiplication, if you consider, that the quotient must be such a quantity as, multiplied by the divisor, shall give the dividend.

The general rule in division is, "to place the dividend above a small line, and the divisor under it, expunging any letters that may be found in all the quantities of the dividend and divisor, and dividing the coefficients of all the terms by any common measure." Thus, when you divide  $10ab + 15ac$  by  $20ad$ , expunging  $a$  out of all the terms, and dividing all the coefficients by 5, the quotient is  $\frac{2b + 3c}{4d}$ ; and

$$2b) ab + bb \left( \frac{a+b}{2} \right).$$

"Powers of the same root are divided by subtracting their exponents, as they are multiplied by adding them." Thus, if you divide  $a^5$  by  $a^2$ , the quotient is  $a^{5-2}$  or  $a^3$ . And  $b^6$  divided by  $b^4$  gives  $b^{6-4}$  or  $b^2$ ; and  $a^7 b^5$  divided by  $a^2 b^3$  gives  $a^5 b^2$  for the quotient.

"If the quantity to be divided is compound, then you must range its parts according to the dimensions of some one of its letters, as in the following example." In the dividend  $a^3 + 2ab + b^2$ , they are ranged according to the dimensions of  $a$ , the quantity  $a^3$ , where  $a$  is of two dimensions, being placed first,  $2ab$ , where it is of one dimension, next, and  $b^2$ , where  $a$  is not at all, being placed last. "The divisor must be ranged according to the dimensions of the same letters; then you are to divide the first term of the dividend by the first term of the divisor, and to set down the quotient, which, in this example, is  $a$ ; then multiply this quotient by the whole divisor, and subtract the product from the dividend, and the remainder shall give a new dividend, which, in this example, is  $ab + b^2$ ."

$$\begin{array}{r}
 a + b) a^3 + 2ab + b^2 \quad (a + b \\
 \underline{a^3 + ab} \\
 ab + b^2 \\
 \underline{ab + b^2} \\
 0 \quad 0.
 \end{array}$$

"Divide the first term of this new dividend by the first term of the divisor, and set down the quotient, (which in this example is  $b$ ), with its proper sign. Then multiply the whole divisor by this part of the quotient, and subtract the product from the new dividend; and if there is no remainder, the division is finished." If there is a remainder, you are to proceed after the same manner, till no remainder is left; or till it appear that there will be always some remainder.

Some examples will illustrate this operation.

EXAMP. I.  $a + b) a^2 - b^2 \quad (a - b$

$$\begin{array}{r}
 a^2 + ab \\
 \underline{-ab - b^2} \\
 -ab - b^2 \\
 \underline{-ab - b^2} \\
 0 \quad 0.
 \end{array}$$

EXAMP. II.  $a - b) aaa - 3abb + 3abb - bbb \quad (aa - 2ab + bb$

$$\begin{array}{r}
 aaa - aab \\
 \underline{-2aab + 3abb - bbb} \\
 -2aab + 2abb \\
 \underline{-2aab + 2abb} \\
 abb - bbb \\
 \underline{abb - bbb} \\
 0 \quad 0.
 \end{array}$$

It often happens, that the operation may be continued without end, and then you have an *infinite series* for the quotient; and by comparing the first three or four terms you may find what law the terms observe: by which means, without any more division, you may continue the quotient as far as you please. Thus, in dividing 1 by  $1 - a$ , you find the quotient to be  $1 + a + a^2 + a^3 + a^4 + a^5 + \&c.$  which series can be continued as far as you please, by adding the powers of  $a$ .

The operation is thus:

$$\begin{array}{r}
 1 - a) 1 \quad (1 + a + a^2 + a^3 + a^4 + a^5 + \&c. \\
 \underline{1 - a} \\
 + a \\
 \underline{+ a - a^2} \\
 + a^2 \\
 \underline{+ a^2 - a^3} \\
 + a^3 \\
 \underline{+ a^3 - a^4} \\
 + a^4 \\
 \underline{+ a^4 - a^5} \\
 + a^5 + \&c.
 \end{array}$$

Note, The sign + placed between any two quantities,

ties, expresses the quotient of the former divided by the latter. Thus,  $\frac{a+b+a-x}{a-x}$  is the quotient of  $a+b$ , divided by  $a-x$ .

CHAP. V. Of FRACTIONS.

In the last chapter it was said, that the quotient of any quantity  $a$ , divided by  $b$ , is expressed by placing  $a$  above a small line, and  $b$  under it, thus,  $\frac{a}{b}$ . These quotients are also called *fractions*; and the dividend, or quantity placed above the line, is called the *numerator* of the fraction, and the divisor, or quantity placed under the line, is called the *denominator*.

“If the numerator of a fraction be equal to the denominator, then the fraction is equal to unity. Thus,  $\frac{a}{a}$  and  $\frac{b}{b}$  are equal to unit. If the numerator is greater than the denominator, then the fraction is greater than unit.” In both these cases, the fraction is called *improper*. But “if the numerator is less than the denominator, then the fraction is less than unit,”

and is called *proper*. Thus,  $\frac{5}{3}$  is an improper fraction; but  $\frac{3}{4}$  and  $\frac{2}{3}$  are proper fractions. A mixt quantity is that whereof one part is an *integer*, and the other a *fraction*. As  $3\frac{4}{5}$  and  $5\frac{2}{3}$  and  $a + \frac{a^2}{b}$ .

PROBLEM I.

To reduce a MIXT quantity to an IMPROPER FRACTION.

RULE. Multiply the part that is an integer by the denominator of the fractional part; and to the product add the numerator; under their sum place the former denominator.

Thus  $2\frac{1}{3}$  reduced to an improper fraction gives  $\frac{7}{3}$ ;  $a + \frac{a^2}{b} = \frac{ab + a^2}{b}$ ; and  $a - x + \frac{a^2 - ax}{x} = \frac{a^2 - x^2}{x}$ .

PROBLEM II.

To reduce an IMPROPER fraction to a MIXT QUANTITY.

RULE. Divide the numerator of the fraction by the denominator, and the quotient shall give the integral part; the remainder set over the denominator shall be the fractional part.

Thus  $\frac{12}{5} = 2\frac{2}{5}$ ;  $\frac{a^2 + a^2}{b} = a + \frac{a^2}{b}$ .

PROBLEM III.

To reduce fractions of different denominations to fractions of equal value that shall have the same denominator.

RULE. Multiply each numerator, separately taken, into all the denominators but its own, and the products shall give the new numerators. Then multiply all the denominators into one another, and the product shall give the common denominator. Thus,

The fractions  $\frac{a}{b}, \frac{b}{c}, \frac{c}{d}$ , are respectively equal to these fractions  $\frac{acd}{bcd}, \frac{bcd}{bcd}, \frac{ccb}{bcd}$ , which have the same denominator  $bcd$ . And the fractions  $\frac{1}{3}, \frac{1}{4}, \frac{1}{5}$ , are respectively equal to these  $\frac{20}{120}, \frac{30}{120}, \frac{24}{120}$ .

PROBLEM IV.

To ADD and SUBTRACT fractions.

RULE. Reduce them to a common denominator, and add or subtract the numerators; the sum or difference set over the common denominator, is the sum or remainder required.

$$\frac{a}{b} + \frac{c}{d} + \frac{d}{e} = \frac{ade + bce + d^2 b}{bde}; \frac{a}{b} - \frac{c}{d} = \frac{ad - bc}{bd}; \frac{2}{3} + \frac{3}{4} = \frac{8 + 9}{12} = \frac{17}{12}; \frac{3}{4} - \frac{2}{3} = \frac{9 - 8}{12} = \frac{1}{12}; \frac{4}{5} - \frac{3}{4} = \frac{16 - 15}{20} = \frac{1}{20}; \frac{x}{2} - \frac{x}{3} = \frac{3x - 2x}{6} = \frac{x}{6}.$$

PROBLEM V.

To MULTIPLY fractions.

RULE. Multiply their numerators one into another to obtain the numerator of the product; and their denominators multiplied into one another shall give the denominator of the product. Thus,

$$\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}; \frac{2}{3} \times \frac{4}{5} = \frac{8}{15}.$$

If a mixt quantity is to be multiplied, first reduce it to the form of a fraction (by Prob. I.) And, if an integer is to be multiplied by a fraction, you may reduce it to the form of a fraction by placing unit under it.

EXAMP.  $5\frac{2}{3} \times \frac{3}{4} = \frac{17}{3} \times \frac{3}{4} = \frac{51}{12}$ .

PROBLEM VI.

To DIVIDE Fractions.

RULE. Multiply the numerator of the dividend by the denominator of the divisor, their product shall give the numerator of the quotient. Then multiply the denominator of the dividend by the numerator of the divisor, and their product shall give the denominator.

Thus,  $\frac{4}{5} \div \frac{2}{3} = \frac{10}{12}; \frac{3}{7} \div \frac{5}{8} = \frac{35}{24}; \frac{c}{d} \div \frac{a}{b} = \frac{cb}{ad}$ .

To

PROBLEM VII.

To find the greatest common measure of two numbers; that is, the greatest number that can divide them both without a remainder.

RULE. First divide the greater number by the lesser, and if there is no remainder, the lesser number is the greatest common divisor required. If there is a remainder, divide your last divisor by it; and thus proceed continually, dividing the last divisor by its remainder, till there is no remainder left, and then the last divisor is the greatest common measure required.

Thus, the greatest common measure of 45 and 63 is 9; and the greatest common measure of 256 and 48 is 16.

$$\begin{array}{r}
 45) 63 \text{ (1)} \\
 \underline{45} \\
 18) 45 \text{ (2)} \\
 \underline{36} \\
 9) 18 \text{ (2)} \\
 \underline{18} \\
 0
 \end{array}
 \qquad
 \begin{array}{r}
 48) 256 \text{ (5)} \\
 \underline{240} \\
 16) 48 \text{ (3)} \\
 \underline{48} \\
 0
 \end{array}$$

Much after the same manner the greatest common measure of algebraic quantities is discovered; only the remainders that arise in the operation are to be divided by their simple divisors, and the quantities are always to be ranged according to the dimensions of the same letter.

Thus to find the greatest common measure of  $a^2 - b^2$  and  $a^2 - 2ab + b^2$ ;

$$\begin{array}{r}
 a^2 - b^2) a^2 - 2ab + b^2 \text{ (1)} \\
 \underline{a^2 - b^2} \\
 -2ab + 2b^2 \text{ Remainder,}
 \end{array}$$

which divided by  $-2b$  is reduced to

$$\begin{array}{r}
 a - b) a^2 - b^2 \text{ (a + b)} \\
 \underline{a^2 - b^2} \\
 0 \cdot 0
 \end{array}$$

Therefore  $a - b$  is the greatest common measure required.

The ground of this operation is, That any quantity that measures the divisor and the remainder (if there is any) must also measure the dividend; because the dividend is equal to the sum of the divisor multiplied into the quotient, and of the remainder added together. Thus, in the last example,  $a - b$  measures the divisor  $a^2 - b^2$ , and the remainder  $-2ab + 2b^2$ ; it must therefore likewise measure their sum  $a^2 - 2ab + b^2$ . You must observe in this operation to make that the dividend which has the highest powers of the letter, according to which the quantities are ranged.

PROBLEM VIII.

To reduce any fraction to its lowest terms.

RULE. Find the greatest common measure of the numerator and denominator; divide them by that com-

mon measure, and place the quotients in their rooms, and you shall have a fraction equivalent to the given fraction expressed in the least terms.

$$\text{Thus, } \frac{25bc}{25bc} \cdot \frac{75abc}{125bcx} = \frac{3a}{5x}; \quad \frac{156aa + 156ab}{572aa - 572ab} = \frac{3a + 3b}{11a - 11b}$$

When unit is the greatest common measure of the numbers and quantities, then the fraction is already in its lowest terms. Thus  $\frac{3a}{5dc}$  cannot be reduced lower.

And, numbers whose greatest common measure is unit, are said to be prime to one another.

If a vulgar fraction is to be reduced to a decimal (that is, a fraction whose denomination is 10, or any of its powers,) "annex as many cyphers as you please to the numerator, and then divide it by the denominator, the quotient shall give a decimal equal to the vulgar fraction proposed." Thus,

$$\frac{2}{3} = .66666, \text{ \&c.} \qquad \frac{3}{5} = .6; \qquad \frac{2}{7} = .2857142, \text{ \&c.}$$

These fractions are added and subtracted like whole numbers; only care must be taken to set similar places above one another, as units above units, and tenths above tenths, &c. They are multiplied and divided as integer numbers; only there must be as many decimal places in the product as in both the multiplicand and multiplier; and in the quotient as many as there are in the dividend more than in the divisor. And in division the quotient may be continued to any degree of exactness you please, by adding cyphers to the dividend. The ground of these operations is easily understood from the general rules for adding, multiplying, and dividing fractions.

CHAP. VI. Of the INVOLUTION of QUANTITIES.

THE products arising from the continual multiplication of the same quantity were called (in Chap. III.) the powers of that quantity. Thus,  $a, a^2, a^3, \text{ \&c.}$  are the powers of  $a$ ; and  $a b, a^2 b^2, a^3 b^3, \text{ \&c.}$  are the powers of  $a b$ . In the same chapter, the rule for the multiplication of powers of the same quantity is, "To add the exponents, and make their sum the exponent of the product." Thus  $a^4 \times a^5 = a^9$ ; and  $a^3 b^3 \times a^6 b^2 = a^9 b^5$ . In Chap. IV. you have the rule for dividing powers of the same quantity, which is "To subtract the exponents, and make the difference the exponent of the quotient."

$$\text{Thus, } \frac{a^6}{a^4} = a^6 - 4 = a^2; \text{ and } \frac{a^5 b^3}{a^4 b} = a^{5-4} b^{3-1} = a b^2.$$

If you divide a lesser power by a greater, the exponent of the quotient must, by this rule, be negative. Thus,



Thus,  $\frac{a^4}{a^6} = a^4 - 6 = a^{-2}$ . But,  $\frac{a^4}{a^6} = \frac{1}{a^2}$ ; and hence  $\frac{1}{a^2}$  is expressed also by  $a^2$  with a negative exponent.

It is also obvious, that  $\frac{a}{a} = a^1 - 1 = a^0$ ; but  $\frac{a}{a} = 1$ , and therefore  $a^0 = 1$ . After the same manner  $\frac{1}{a} = \frac{a^0}{a} = a^0 - 1 = a^{-1}$ ;  $\frac{1}{a a} = \frac{a^0}{a^2} = a^0 - 2 = a^{-2}$ ;  $\frac{1}{a a a} = a^0 - 3 = a^{-3}$ ; so that the quantities  $a, 1, \frac{1}{a}, \frac{1}{a^2}, \frac{1}{a^3}, \frac{1}{a^4}, \&c.$  may be expressed thus,  $a^1, a^0, a^{-1}, a^{-2}, a^{-3}, a^{-4}, \&c.$  Those are called the *negative powers* of  $a$  which have negative exponents; but they are at the same time *positive powers* of  $\frac{1}{a}$  or  $a^{-1}$ .

*Negative powers (as well as positive) are multiplied by adding, and divided by subtracting their exponents.*

Thus the product of  $a^{-3}$  (or  $\frac{1}{a^3}$ ) multiplied by  $a^{-3}$  (or  $\frac{1}{a^3}$ ) is  $a^{-3-3} = a^{-6}$  (or  $\frac{1}{a^6}$ ); also  $a^{-6} \times a^3 = a^{-6+3} = a^{-3}$  (or  $\frac{1}{a^3}$ ); and  $a^{-3} \times a^3 = a^0 = 1$ . And, in general, any positive power of  $a$  multiplied by a negative power of  $a$  of an equal exponent gives UNIT for the product; for the positive and negative destroy each other, and the product gives  $a^0$ , which is equal to unit.

Likewise  $\frac{a^{-5}}{a^{-3}} = a^{-5+3} = a^{-2} = \frac{1}{a^2}$ ; and  $\frac{a^{-2}}{a^{-5}} = a^{-2+5} = a^3$ . But also,  $\frac{a^{-2}}{a^{-3}} = \frac{a^{-2}}{a^{-3} \times a^{-3}} = \frac{1}{a^{-3}}$ ; therefore  $\frac{1}{a^{-3}} = a^3$ : And, in general, "Any quantity placed in the denominator of a fraction may be transposed to the numerator, if the sign of its exponent be changed." Thus  $\frac{1}{a^3} = a^{-3}$ , and  $\frac{1}{a^{-3}} = a^3$ .

The quantity  $a^m$  expresses any power of  $a$  in general; the exponent ( $m$ ) being undetermined; and  $a^{-m}$  expresses  $\frac{1}{a^m}$ , or a negative power of  $a$  of an equal exponent: and  $a^m \times a^{-m} = a^{m-m} = a^0 = 1$  is their product.  $a^n$  expresses any other power of  $a$ ;  $a^m \times a^n = a^{m+n}$  is the product of the powers  $a^m$  and  $a^n$ , and  $a^{m-n}$  is their quotient.

To raise any simple quantity to its second, third, or fourth power, is to add its exponent twice, thrice, or four times to itself; therefore the second power of any quantity is had by doubling its exponent, and the third by trebling its exponent; and, in general, the power expressed by  $m$  of any quantity is had by multiplying the exponent by  $m$ , as is obvious from the multiplication of powers. Thus the second power or square of  $a$  is

$a^2 \times 2 = a^4$ ; its third power or cube is  $a^3 \times 3 = a^9$ ; and the  $m^{\text{th}}$  power of  $a$  is  $a^m \times m = a^m$ . Also, the square of  $a^4$  is  $a^4 \times 2 = a^8$ ; the cube of  $a^4$  is  $a^4 \times 3 = a^{12}$ ; and the  $m^{\text{th}}$  power of  $a^4$  is  $a^4 \times m$ . The square of  $a b c$  is  $a^2 b^2 c^2$ , the cube is  $a^3 b^3 c^3$ , the  $m^{\text{th}}$  power  $a^m b^m c^m$ .

The raising of quantities to any power is called *involution*, and any simple quantity is involved by multiplying the exponent by that of the power required, as in the preceding examples.

The coefficient must also be raised to the same power by a continual multiplication of itself by itself, as often as unit is contained in the exponent of the power required. Thus the cube of  $3 a b$  is  $3 \times 3 \times 3 \times a^3 b^3 = 27 a^3 b^3$ .

As to the signs, When the quantity to be involved is positive, it is obvious that all its powers must be positive. And, when the quantity to be involved is negative, yet all its powers, whose exponents are even numbers, must be positive: for any number of multiplications of a negative, if the number be even, gives a positive; since  $- \times - = +$ , therefore  $- \times - \times - \times - = + \times + = +$ ; and  $- \times - \times - \times - \times - \times - = + \times + \times + = +$ .

The power then only can be negative when its exponent is an odd number, though the quantity to be involved be negative. The powers of  $-a$  are  $-a, +a^2, -a^3, +a^4, -a^5, \&c.$  Those whose exponents are 2, 4, 6, &c. are positive; but those whose exponents are 1, 3, 5, &c. are negative.

The involution of compound quantities is a more difficult operation. The powers of any binomial  $a + b$  are found by a continual multiplication of it by itself, as follows:

$$\begin{array}{r}
 a + b = \text{Root.} \\
 \times a + b \\
 \hline
 a^2 + ab \\
 + ab + b^2 \\
 \hline
 a^2 + 2ab + b^2 = \text{the square or 2d power.} \\
 \times a + b \\
 \hline
 a^3 + 2a^2b + ab^2 \\
 + a^2b + 2ab^2 + b^3 \\
 \hline
 a^3 + 3a^2b + 3ab^2 + b^3 = \text{cube or 3d power, } \&c.
 \end{array}$$

If the powers of  $a - b$  are required, they will be found the same as the preceding, only the terms in which the exponent of  $b$  is an odd number, will be found negative; "because an odd number of multiplications of a negative produces a negative." Thus, the cube of  $a - b$  will be found to be  $a^3 - 3a^2b + 3ab^2 - b^3$ : Where the 2d and 4th terms are negative, the exponent of  $b$  being an odd number in these terms. In general, "The terms of any power of  $a - b$  are positive and negative by turns."

It is to be observed, That "in the first term of any power of  $a - b$ , the quantity  $a$  has the exponent of the power required; that in the following terms, the exponents of  $a$  decrease gradually by the same difference

ence (*viz.* unit), and that in the last terms it is never found. The powers of  $b$  are in the contrary order; it is not found in the first term, but its exponent in the second term is unit, in the third term its exponent is 2; and thus its exponent increases, till in the last term it becomes equal to the exponent of the power required."

As the exponents of  $a$  thus decrease, and at the same time those of  $b$  increase, "the sum of their exponents is always the same, and is equal to the exponent of the power required." Thus, in the 6th power of  $a + b$ , *viz.*  $a^6 + 6a^5b + 15a^4b^2 + 20a^3b^3 + 15a^2b^4 + 6ab^5 + b^6$ , the exponents of  $a$  decrease in this order, 6, 5, 4, 3, 2, 1, 0; and those of  $b$  increase in the contrary order, 0, 1, 2, 3, 4, 5, 6. And the sum of their exponents in any term is always 6.

To find the coefficient of any term, the coefficient of the preceding term being known, you are to "divide the coefficient of the preceding term by the exponent of  $b$  in the given term, and to multiply the quotient by the exponent of  $a$  in the same term, increased by unit." Thus to find the coefficients of the terms of the 6th power of  $a + b$ , you find the terms are

$$a^6, a^5b, a^4b^2, a^3b^3, a^2b^4, ab^5, b^6;$$

and you know the coefficient of the first term is unit; therefore, according to the rule, the coefficient of the second term will be  $\frac{1}{1} \times 6 = 6$ ; that of the third

term will be  $\frac{6}{2} \times 5 = 15$ ; that of the

fourth term will be  $\frac{15}{3} \times 4 = 20$ ; and those of the following will be 15, 6, 1, agreeable to the preceding table.

In general, if  $a + b$  is to be raised to any power  $m$ , the terms, without their coefficients will be  $a^m, a^{m-1}b, a^{m-2}b^2, a^{m-3}b^3, a^{m-4}b^4, \dots$  continued till the exponent of  $b$  becomes equal to  $m$ .

The coefficients of the respective terms, according to the last rule, will be

$$1, m, m \times \frac{m-1}{2}, m \times \frac{m-1}{2} \times \frac{m-2}{3}, m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4}, m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4} \times \frac{m-4}{5},$$

&c. continued until you have one coefficient more than there are units in  $m$ .

It follows therefore by these last rules, that  $(a + b)^m = a^m + m a^{m-1}b + m \times \frac{m-1}{2} a^{m-2}b^2 + m \times \frac{m-1}{2} \times \frac{m-2}{3} a^{m-3}b^3 + m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4} a^{m-4}b^4 + \dots$  which is the general theorem for raising a quantity consisting of two terms to any power  $m$ .

If a quantity consisting of three or more terms is to be involved, "you may distinguish it into two parts, considering it as a binomial, and raise it to any power by the preceding rules; and then, by the same rules, you may substitute, instead of the powers of these compound parts, their values." Thus,

$$(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2ac + 2bc$$

In these examples,  $a + b + c$  is considered as composed of the compound part  $a + b$  and the simple part  $c$ ; and then the powers of  $a + b$  are formed by the preceding rules, and substituted for  $a + b$  and  $a + b^2$ .

## CHAP. VII. Of EVOLUTION.

THE reverse of involution, or the resolving of powers into their roots, is called *evolution*. The roots of single quantities are easily extracted "by dividing their exponents by the number that denominates the root required." Thus, the square root of  $a^4$  is  $a^2 = a^{\frac{4}{2}}$ ; and the square root of  $a^4 b^8 c^2$  is  $a^2 b^4 c$ . The cube root of  $a^6 b^3$  is  $a^2 b$ ; and the cube root of  $x^3 y^6 z^{12}$  is  $x y^2 z^4$ . The ground of this rule is obvious from the rule for involution. The powers of any root are found by multiplying its exponent by the index that denominates the power; and therefore, when any power is given, the root must be found by dividing the exponent of the given power by the number that denominates the kind of root that is required.

It appears, from what was said of involution, that "any power that has a positive sign may have either a positive or negative root, if the root is denominated by any even number." Thus the square-root of  $+a^2$  may be  $+a$  or  $-a$ , because  $+a \times +a$  or  $-a \times -a$  gives  $+a^2$  for the product.

But if a power have a negative sign, "no root of it denominated by an even number can be assigned," since there is no quantity that multiplied into itself an even number of times can give a negative product. Thus the square root of  $-a^2$  cannot be assigned, and is what we call an *impossible* or *imaginary* quantity.

But if the root to be extracted is denominated by an odd number, then shall "the sign of the root be the same as the sign of the given number, whose root is required." Thus the cube root of  $-a^3$  is  $-a$ , and the cube root of  $-a^6 b^3$  is  $-a^2 b$ .

If the number that denominates the root required is a divisor of the exponent of the given power, then shall the root be only a *lower power of the same quantity*. As the cube root of  $a^{12}$  is  $a^4$ , the number 3 that denominates the cube root being a divisor of 12.

But if the number that denominates what sort of root is required is not a divisor of the exponent of the given power, "then the root required shall have a fraction for its exponent." Thus the square root of  $a^3$  is  $a^{\frac{3}{2}}$ ; the cube root of  $a^5$  is  $a^{\frac{5}{3}}$ , and the square root of  $a$  itself is  $a^{\frac{1}{2}}$ .

These powers that have fractional exponents are called *imperfect powers* or *surds*; and are otherwise expressed by placing the given power within the radical sign  $\sqrt{\quad}$ , and placing above the radical sign the number that denominates what kind of root is required. Thus  $a^{\frac{3}{2}} = \sqrt[2]{a^3}$ ,

$a^{\frac{5}{3}} = \sqrt[3]{a^5}$ ; and  $a^{\frac{m}{n}} = \sqrt[n]{a^m}$ . In numbers the square root of 2 is expressed by  $\sqrt{2}$ , and the cube root of 4 by  $\sqrt[3]{4}$ .

The

The square root of any compound quantity, as  $a^2 + 2ab + b^2$  is discovered after this manner. "First, take care to dispose the terms according to the dimensions of the alphabet, as in division; then find the square root of the first term  $a^2$ , which gives  $a$  for the first member of the root. Then subtract its square from the proposed quantity, and divide the first term of the remainder ( $2ab + b^2$ ) by the double of that member, viz.  $2a$ , and the quotient  $b$  is the second member of the root. Add this second member to the double of the first, and multiply their sum ( $2a + b$ ) by the second member  $b$ , and subtract the product ( $2ab + b^2$ ) from the foresaid remainder ( $2ab + b^2$ ) and if nothing remains, then the square root is obtained;" and in this example it is found to be  $a + b$ .

The manner of the operation is thus,

$$\begin{array}{r}
 a^2 + 2ab + b^2 \quad (a + b \\
 \underline{a^2} \\
 2ab + b^2 \\
 \underline{\times b} \quad 2ab + b^2 \\
 \hline
 0 \quad 0
 \end{array}$$

"But if there had been a remainder, you must have divided it by the double of the sum of the two parts already found, and the quotient would have given the third member of the root."

Thus, if the quantity proposed had been  $a^2 + 2ab + 2ac + b^2 + 2bc + c^2$ , after proceeding as above, you would have found the remainder  $2ac + 2bc + c^2$ , which divided by  $2a + 2b$  gives  $c$  to be annexed to  $a + b$  as the 3d member of the root. Then adding  $c$  to  $2a + 2b$ , and multiplying their sum  $2a + 2b + c$  by  $c$ , subtract the product  $2ac + 2bc + c^2$  from the foresaid remainder; and since nothing now remains, you conclude that  $a + b + c$  is the square root required.

The square root of any number is found out after the same manner. If it is a number under 100, its nearest square root is found by the following table; by which also its cube root is found if it be under 1000, and is biquadrate if it be under 10000.

The root	1	2	3	4	5	6	7	8	9
Square	1	4	9	16	25	36	49	64	81
Cube	1	8	27	64	125	216	343	512	729
Big quad.	1	16	81	256	625	1296	2401	4096	6561

But if it is a number above 100, then its square root will consist of two or more figures, which must be found by different operations by the following

R U L E.

"To find the square root of any number, place a point above the number that is in the place of units, pass the place of tens, and place again a point over that of hundreds, and go on towards the left hand placing a point over every 2d figure; and by these points the number will be distinguished into as many parts as there are figures in the root. Then find the square root of the first part, and it will give the first figure of

the root; subtract its square from that part, and annex the second part of the given number to the remainder. Then divide this new number (neglecting its last figure) by the double of the first figure of the root, annex the quotient to that double, and multiply the number thence arising by the said quotient, and if the product is less than your dividend, or equal to it, that quotient shall be the second figure of the root. But if the product is greater than the dividend, you must take a less number for the second figure of the root than that quotient." Much after the same manner may the other figures of the quotient be found, if there are more points than two placed over the given number.

To find the square root of 99856, first point it thus, 99856; then find the square root of 9 to be 3, which therefore is the first figure of the root; subtract 9, the square of 3, from 9, and to the remainder annex the second part 98, and divide (neglecting the last figure 8) by the double of 3, or 6, and place the quotient after 6, and then multiply 61 by 1, and subtract the product 61 from 98. Then to the remainder (37) annex the last part of the proposed number (56), and dividing 3756 (neglecting the last figure 6) by the double of 31, that is by 62, place the quotient after, and multiplying 626 by the quotient 6, you will find the product to be 3756, which subtracted from the dividend, and leaving no remainder, the exact root must be 316.

EXAMP.

$$\begin{array}{r}
 99856 \quad (316 \\
 \underline{9} \\
 61 \quad 98 \\
 \times 1 \quad 61 \\
 \hline
 626 \quad 3756 \\
 \times 6 \quad 3756 \\
 \hline
 0
 \end{array}$$

In general, to extract any root out of any given quantity, "First range that quantity according to the dimensions of its letters, and extract the said root out of the first term, and that shall be the first member of the root required. Then raise this root to a dimension lower by unit than the number that denominates the root required, and multiply the power that arises by that number itself; divide the second term of the given quantity by the product, and the quotient shall give the second member of the root required."

Thus to extract the root of the 5th power out of  $a^5 + 5a^4b + 10a^3b^2 + 10a^2b^3 + 5ab^4 + b^5$ , I find, that the root of the 5th power out of  $a^5$  gives  $a$ , which I raise to the 4th power, and multiplying by 5, the product is  $5a^4$ ; then dividing the second term of the given quantity  $5a^4b$  by  $5a^4$ , I find  $b$  to be the second member; and raising  $a + b$  to the 5th power, and subtracting it, there being no remainder, I conclude that  $a + b$  is the root required. If the root has three members, the third is found after the same manner from the first two considered as one member, as the second member was found from the first; which may be easily understood from what was said of extracting the square root.

Ia

In extracting roots it will often happen that the exact root cannot be found in finite terms; thus the square root of  $a^2 + x^2$  is found to be

$$a + \frac{x^2}{2a} - \frac{x^4}{8a^3} + \frac{x^6}{16a^5} - \frac{5x^8}{128a^7} + \dots$$

The operation is thus;

$$a^2 + x^2 \left( a + \frac{x^2}{2a} - \frac{x^4}{8a^3} + \frac{x^6}{16a^5} - \dots \right)$$

$$2a + \frac{x^2}{2a} \Big) + x^2$$

$$\times \frac{x^2}{2a} = x^2 + \frac{x^4}{4a^2}$$

$$2a + \frac{x^2}{a} - \frac{x^4}{8a^3} \Big) - \frac{x^4}{4a^2}$$

$$\times - \frac{x^4}{8a^3} = - \frac{x^4}{4a^2} - \frac{x^6}{8a^4} + \frac{x^8}{64a^6}$$

$$+ \frac{x^6}{8a^4} - \frac{x^8}{64a^6} \dots$$

"The general theorem which we gave for the involution of binomials will serve also for their evolution;" because to extract any root of a given quantity is the same thing as raise that quantity to a power whose exponent is a fraction that has its denominator equal to the number that expresses what kind of root is to be extracted. Thus, to extract the square root of  $a + b$  is to raise  $a + b$  to a power whose exponent is  $\frac{1}{2}$ .

The roots of numbers are to be extracted as those of algebraic quantities. "Place a point over the units, and then place points over every third, fourth, or fifth figure towards the left hand, according as it is the root of the cube, of the 4th or 5th power that is required; and, if there be any decimals annexed to the number, point them after the same manner, proceeding from the place of units towards the right hand. By this means the number will be divided into so many periods as there are figures in the root required. Then inquire which is the greatest cube, biquadrate, or 5th power in the first period, and the root of that power will give the first figure of the root required. Subtract the greatest cube, biquadrate, or 5th power, from the first period, and to the remainder annex the first figure of your second period, which shall give your dividend.

"Raise the first figure already found to a power less by unit than the power whose root is sought, that is, to the 2d, 3d, or 4th power, according as it is the cube root, the root of the 4th, or the root of the 5th power that is required, and multiply that power by the index of the cube, 4th, or 5th power, and divide the dividend by this product, so shall the quotient be the second figure of the root required.

"Raise the part already found of the root, to the power whose root is required, and if that power be

"found less than the two first periods of the given number, the second figure of the root is right. But, if it be found greater, you must diminish the second figure of the root till that power be found equal to or less than those periods of the given number. Subtract it, and to the remainder annex the next period; and proceed till you have gone through the whole given number, finding the third figure by means of the two first, as you found the second by the first; and afterwards finding the fourth figure (if there be a fourth period) after the same manner from the three first."

Thus to find the cube root of 13824, point it 13824; find the greatest cube in 13, viz. 8, whose cube root 2 is the first figure of the root required. Subtract 8 from 13, and to the remainder 5 annex 8, the first figure of the second period; divide 58 by triple the square of 2, viz. 12, and the quotient is 4, which is the second figure of the root required, since the cube of 24 gives 13824, the number proposed. After the same manner the cube root of 13312053 is found to be 237.

$$\begin{array}{r} 13824 \text{ (24)} \\ \text{Subtr. } 8 = 2 \times 2 \times 2 \end{array}$$

$$\begin{array}{r} 3 \times 4 = 12 \text{ (4)} \\ \text{Subtr. } 24 \times 24 \times 24 = 13824 \end{array}$$

Rem. . . . 0 . . .

In extracting of roots, after you have gone through the number proposed, if there is a remainder, you may continue the operation by adding periods of cyphers to that remainder, and find the true root in decimals to any degree of exactness.

CHAP. VIII. OF PROPORTION.

WHEN quantities of the same kind are compared, it may be considered, either how much the one is greater than the other, and what is their difference; or, it may be considered how many times the one is contained in the other; or, more generally, what is their quotient. The first relation of quantities is expressed by their arithmetical ratio; the second by their geometrical ratio. That term whose ratio is inquired into is called the antecedent, and that with which it is compared is called the consequent.

When of four quantities the difference betwixt the first and second is equal to the difference betwixt the third and fourth, those quantities are called arithmetical proportionals; as the numbers 3, 7, 12, 16. And the quantities  $a, a+b, c, c+b$ . But quantities form a series in arithmetical proportion, when they "increase or decrease by the same constant difference." As these,  $a, a+b, a+2b, a+3b, a+4b, \dots$   $x, x-b, x-2b, \dots$  or the numbers 1, 2, 3, 4, 5,  $\dots$  and 10, 7, 4, 1, -2, -5, -8,  $\dots$

In four quantities arithmetically proportional, "the sum of the extremes is equal to the sum of the mean terms."



“ The sum of a series of geometrical proportionals wanting the first term, is equal to the sum of all but the last term multiplied by the common ratio.”

$$\text{For } ar + ar^2 + ar^3, \&c. + \frac{y}{r^3} + \frac{y}{r^2} + \frac{y}{r} + y = \\ = r \times a + ar + ar^2, \&c. + \frac{y}{r^4} + \frac{y}{r^3} + \frac{y}{r^2} + \frac{y}{r}.$$

Therefore if  $s$  be the sum of the series,  $s - a$  will be equal to  $s - y \times r$ ; that is,  $s - a = sr - yr$ , or  $sr - s = yr - a$ , and  $s = \frac{yr - a}{r - 1}$ .

Since the exponent of  $r$  is always increasing from the second term, if the number of terms be  $n$ , in the last term its exponent will be  $n - 1$ . Therefore  $y = ar^{n-1}$ ; and  $yr = ar^{n-1} \times r = ar^n$ ; and  $s = \left( \frac{yr - a}{r - 1} \right) = \frac{ar^n - a}{r - 1}$ . So that having the first term of the series, the number of the terms, and the common ratio, you may easily find the sum of all the terms.

If it is a decreasing series whose sum is to be found, as of  $y + \frac{y}{r} + \frac{y}{r^2} + \frac{y}{r^3}$ , &c.  $+ ar^3 + ar^2 + ar + a$ , and the number of the terms be supposed infinite, then shall  $a$ , the last term, be equal to nothing. For, because  $n$ , and consequently  $r^{n-1}$  is infinite,  $a = \frac{r}{r^{n-1}} = 0$ .

The sum of such a series  $= \frac{yr}{r - 1}$ ; which is a finite sum, though the number of terms be infinite. Thus,

$$1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} +, \&c. = \frac{1 \times 2}{2 - 1} = 2.$$

$$\text{and } 1 + \frac{1}{3} + \frac{1}{9} + \frac{1}{27} + \frac{1}{81} +, \&c. = \frac{1 \times 3}{3 - 1} = \frac{3}{2}$$

### CHAP. IX. Of EQUATIONS that involve only one unknown Quantity.

An equation is “ a proposition asserting the equality of two quantities.” It is expressed most commonly by setting down the quantities, and placing the sign (=) between them.

An equation gives the value of a quantity, when that quantity is alone on one side of the equation: and that value is known, if all those that are on the other side are known. Thus if I find that  $x = \frac{4 \times 6}{3} = 8$ , I have a known value of  $x$ . These are the last conclusions we are to seek in questions to be resolved; and if there be only one unknown quantity in a given equation, and only one dimension of it, such a value may always be found by the following rules.

**RULE I.** Any quantity may be transposed from one side of the equation to the other, if you change its sign.

For to take away a quantity from one side, and to place it with a contrary sign on the other side, is to subtract it from both sides; and it is certain, that “ when from e-

qual quantities you subtract the same quantity, the remainders must be equal.”

By this rule, when the known and unknown quantities are mixed in an equation, you may separate them by bringing all the unknown to one side, and the known to the other side of the equation; as in the following examples.

Suppose  $5x + 50 = 4x + 56$   
by Transposit.  $5x - 4x = 56 - 50$ , or,  $x = 6$   
And if  $2x + a = x + b$   
 $2x - x = b - a$ , or,  $x = b - a$ .

**RULE II.** Any quantity by which the unknown quantity is multiplied may be taken away, if you divide all the other quantities on both sides of the equation by it.

For that is to divide both sides of the equation by the same quantity, and when you divide equal quantities by the same quantity, the quotients must be equal. Thus,

$$\text{If } ax = b \\ \text{then } x = \frac{b}{a};$$

$$\text{and if } 3x + 12 = 27 \\ \text{by Rule 1st. } 3x = 27 - 12 = 15 \\ \text{and by Rule 2d. } x = \frac{15}{3} = 5$$

**RULE III.** If the unknown quantity is divided by any quantity, that quantity may be taken away if you multiply all the other members of the equation by it. Thus,

$$\text{If } \frac{x}{b} = b + 5 \\ \text{then shall } x = bb + 5b$$

By this rule, an equation whereof any part is a fraction may be reduced to an equation that shall be expressed by integers. If there are more fractions than one in the given equation, you may, by reducing them to a common denominator, and then multiplying all the other terms by that denominator, abridge the calculation thus;

$$\text{If } \frac{x}{5} + \frac{x}{3} = x - 7$$

$$\text{then } \frac{3x + 5x}{15} = x - 7$$

and by this Rule  $3x + 5x = 15x - 105$   
and by R. 1. and 2.  $x = \frac{105}{12} = 8\frac{7}{4}$ .

**RULE IV.** If that member of the equation that involves the unknown quantity be a *furd* root, then the equation is to be reduced to another that shall be free from any *furd*, by bringing that member first to stand alone upon one side of the equation, and then taking away the radical sign from it, and raising the other side of the equation to the power denominated by the *furd*.

$$\text{Thus if } \sqrt{4x + 16} = 12 \\ 4x + 16 = 144 \\ \text{and } 4x = 144 - 16 = 128 \\ \text{and } x = \frac{128}{4} = 32.$$

**RULE**

**RULE V.** If that side of the equation that contains the unknown quantity be a compleat square, cube, or other power; then extract the square root, cube root, or the root of that power, from both sides of the equation, and thus the equation shall be reduced to one of a lower degree.

$$\begin{aligned} &\text{If } x^2 + 6x + 9 = 20 \\ &\text{then } x + 3 = \sqrt{20} \\ &\text{and } x = \sqrt{20} - 3. \end{aligned}$$

**RULE VI.** A proportion may be converted into an equation asserting the product of the extreme terms equal to the product of the mean terms; or any one of the extremes equal to the product of the means divided by the other extreme.

$$\begin{aligned} &\text{If } 12 - x : \frac{x}{2} :: 4 : 1 \\ &\text{then } 12 - x = 2x \dots 3x = 12 \dots \text{and } x = 4. \\ &\text{Or if } 20 - x : x :: 7 : 3 \\ &\text{then } 60 - 3x = 7x \dots 10x = 60 \dots \text{and } x = 6. \end{aligned}$$

**RULE VII.** If any quantity be found on both sides of the equation with the same sign prefixed, it may be taken away from both: Also, if all the quantities in the equation are multiplied or divided by the same quantity, it may be struck out of them all. Thus,

$$\text{If } 3x + 4 = a + b \dots 3x = a \dots \text{and } x = \frac{a}{3}.$$

**RULE VIII.** Instead of any quantity in an equation, you may substitute another equal to it.

$$\begin{aligned} &\text{Thus if } 3x + y = 24 \\ &\text{and } y = 9 \\ &\text{then } 3x + 9 = 24 \dots x = \frac{24 - 9}{3} = 5. \end{aligned}$$

The further improvements of this rule shall be taught in the following chapter.

**CHAP. X. Of the SOLUTION of QUESTIONS that produce SIMPLE EQUATIONS.**

**SIMPLE** equations are those "wherein the unknown quantity is only of one dimension." In the solution of which, we are to observe the following directions.

**DIRECT. I.** "After forming a distinct idea of the question proposed, the unknown quantities are to be expressed by letters, and the particulars to be translated from the common language into the algebraic manner of expressing them, that is, into such equations as shall express the relations or properties that are given of such quantities."

Thus, if the sum of two quantities must be 60, that condition is expressed thus,  $x + y = 60$ .  
If their difference must be 24, that condition gives  $x - y = 24$ .

If their product must be 1640, then  $xy = 1640$ .

If their quotient must be 6, then  $\frac{x}{y} = 6$ .

If their proportion is as 3 to 2, then  $x : y :: 3 : 2$  or  $2x = 3y$ ; because the product of the extremes is equal to the product of the mean terms.

**DIRECT. II.** "After an equation is formed, if you have one unknown quantity only, then, by the rules of the preceding chapter, bring it to stand alone on one side, so as to have only known quantities on the other side:" thus you shall discover its value.

**EXAMP.** "A person being asked what was his age, answered that  $\frac{1}{4}$  of his age multiplied by  $\frac{1}{12}$  of his age gives a product equal to his age. *Qu.* What was his age?"

It appears from the question, that if you call his age

$$\begin{aligned} x, \text{ then shall } &\dots \frac{3x}{4} \times \frac{x}{12} = x \\ &\text{that is } \dots \frac{3x^2}{48} = x \\ &\text{and by Rule 3. } \dots 3x^2 = 48x \\ &\text{and by R. 7. } \dots 3x = 48 \\ &\text{whence by R. 2. } \dots x = 16. \end{aligned}$$

**DIRECT. III.** "If there are two unknown quantities, then there must be two equations arising from the conditions of the question: Suppose the quantities  $x$  and  $y$ ; find a value of  $x$  or  $y$  from each of the equations, and then, by putting these two values equal to each other, there will arise a new equation involving one unknown quantity; which must be reduced by the rules of the former chapter."

**EXAMP. I.** "Let the sum of two quantities be  $s$ , and their difference  $d$ . Let  $s$  and  $d$  be given, and let it be required to find the quantities themselves." Suppose them to be  $x$  and  $y$ , then, by the supposition,

$$\begin{aligned} &x + y = s \\ &x - y = d \\ &\text{whence } \begin{cases} x = s - y \\ x = d + y \end{cases} \\ &\text{and } \begin{cases} d + y = s - y \\ 2y = s - d \\ y = \frac{s - d}{2} \end{cases} \\ &\text{and } x = \frac{s + d}{2}. \end{aligned}$$

**EXAMP. II.** "A privateer running at the rate of 10 miles an hour, discovers a ship 18 miles off making way at the rate of 8 miles an hour: It is demanded how many miles the ship can run before she be overtaken?"

Let the number of miles the ship can run before she be overtaken be called  $x$ , and the number of miles the privateer must run before she come up with the ship be  $y$ ; then shall (by supp.)  $y = x + 18 \dots$  and  $x : y :: 8 : 10$  whence

whence  $10x=3y$  . . .  $x=\frac{3y}{5}$  . . and  $x=y-18$ . whence  $y-18=\frac{4y}{5}$  and  $y=90$  . .  $x=y-18=72$ .

To find the time, say, If 8 miles give 1 hour, 72 miles will give 9 hours . . thus, 8:1::72:9.

EXAMP. III. "Suppose the distance between London and Edinburgh to be 360 miles; and that a courier sets out from Edinburgh, running at the rate of 10 miles an hour; another sets out at the same time from London, and runs 8 miles an hour: It is required to know "where they will meet?"

Suppose the courier that sets out from Edinburgh runs  $x$  miles, and the other  $y$  miles, before they meet, then shall,

$$\begin{aligned} \text{by suppos. } \begin{cases} x+y=360 \\ x:y::5:4 \end{cases} \\ \hline x=\frac{5y}{4} \\ x=360-y \\ \frac{5y}{4}=360-y \\ \frac{5y}{4}+y=360 \\ \frac{9y}{4}=1440 \\ y=\frac{1440 \times 4}{9}=160 \\ x=360-y=200 \end{aligned}$$

EXAMP. IV. "Two merchants were copartners; the sum of their stock was 300 l. One of their stocks "continued in company 11 months, but the other drew "out his stock in 9 months; when they made up their "accounts they divided the gain equally. Qu. What "was each man's stock?" Suppose the stock of the first to be  $x$ , and the stock of the other to be  $y$ ; then,

$$\begin{aligned} \text{by suppos. } \begin{cases} x+y=300 \\ 11x=9y \end{cases} \\ \hline x=\frac{9y}{11}=300-y \\ 11y+9y=3300 \\ 20y=3300 \\ y=\frac{3300}{20}=165 \dots x=300-y=135. \end{aligned}$$

DIRECT. IV. "When in one of the given equations the unknown quantity is of one dimension, and "in the other of a higher dimension; you must find a "value of the unknown quantity from that equation "where it is of one dimension, and then raise that value to the power of the unknown quantity in the other "equation; and by comparing it, so involved, with the "value you deduce from that other equation, you shall "obtain an equation that will have only one unknown "quantity, and its powers."

That is, when you have two equations of different dimensions, if you cannot reduce the higher to the same dimension with the lower, you must raise the lower to the same dimension with the higher.

EXAMP. V. "The sum of two quantities, and the "difference of their squares, being given, to find the "quantities." Suppose them to be  $x$  and  $y$ , their sum  $s$ , and the difference of their squares  $d$ . Then,

$$\begin{aligned} \begin{cases} x+y=s \\ x^2-y^2=d \end{cases} & \begin{cases} d+y^2=s^2-2sy+y^2 \\ d=s^2-2sy \\ 2sy=s^2-d \\ y=\frac{s^2-d}{2s} \end{cases} \\ \hline x=s-y & \\ x^2=s^2-2sy+y^2 & \\ x^2=d+y^2, \text{ whence } & \text{ and } x=\frac{s^2+d}{2s} \end{aligned}$$

DIRECT. V. "If there are three unknown quantities, there must be three equations in order to determine them, by comparing which, you may, in all cases, "find two equations involving only two unknown quantities; and then, by *Direct.* 3d, from these two you "may deduce an equation involving only one unknown "quantity; which may be resolved by the rules of the "last chapter."

From three equations involving any three unknown quantities,  $x$ ,  $y$ , and  $z$ , to deduce two equations, involving only two unknown quantities, the following rule will always serve.

RULE. "Find three values of  $x$  from the three given equations; then, by comparing the first and second value, you will find an equation involving only  $y$  and  $z$ ; again, by comparing the first and third, you will find another equation involving only  $y$  and  $z$ ; and, lastly, those equations are to be resolved by *Dir.* 3.

EXAMP. VI.

$$\begin{aligned} \text{Suppose} \\ \begin{cases} x+y+z=12 \\ x+2y+3z=20 \\ \frac{x}{3}+\frac{y}{2}+z=6 \end{cases} \text{ then, } \begin{cases} 12-y-z \\ 20-2y-3z \\ 18-\frac{3y}{2}-3z \end{cases} \begin{matrix} 1\text{ft} \\ 2\text{d} \\ 3\text{d} \end{matrix} \text{ Value.} \\ \hline 12-y-z=20-2y-3z \\ 12-y-z=18-\frac{3y}{2}-3z \end{aligned}$$

These two last equations involve only  $y$  and  $z$ , and are to be resolved by *Direct.* 3d, as follows,

$$\begin{aligned} \begin{cases} 2y-y+3z-z=20-12=8 \\ y+2z=8 \end{cases} \\ \hline 36-3y-6z=24-2y-2z \\ 12=y+4z \\ \text{whence } y= \begin{cases} 8-2z \dots 1\text{ft value} \\ 12-4z \dots 2\text{d value} \end{cases} \\ \hline 8-2z=12-4z \\ 2z=12-8=4 \\ z=2 \\ y(=8-2z)=4 \\ x(=12-y-z)=6. \end{aligned}$$

This method is general, and will extend to all equations that involve 3 unknown quantities: but there are often



often easier and shorter methods to deduce an equation involving one unknown quantity only; which will be best learned by practice.

EXAMP. VII.  $\begin{cases} x+y=a \\ x+z=b \\ y+z=c \end{cases}$   
 Supp.

$$\begin{aligned} x &= a - y \\ a - y + z &= b \\ y + z &= c \end{aligned}$$

$$a + 0 + z = b + c$$

$$2z = b + c - a$$

$$z = \frac{b+c-a}{2}$$

$$y (=c-z) = \frac{c+a-b}{2}$$

$$x (=a-y) = \frac{a+b-c}{2}$$

It is obvious from the 3d and 5th directions, in what manner you are to work if there are four, or more, unknown quantities, and four, or more, equations given. By comparing the given equations, you may always at length discover an equation involving only one unknown quantity; which, if it is a simple equation, may always be resolved by the rules of the last chapter. We may conclude then, that "When there are as many simple equations given as quantities required, these quantities may be discovered by the application of the preceding rules."

If indeed there are more quantities required than equations given, then the question is not limited to determinate quantities; but is capable of an infinite number of solutions. And, if there are more equations given than there are quantities required, it may be impossible to find the quantities that will answer the conditions of the question; because some of these conditions may be inconsistent with others.

CHAP. XI. *Containing some general THEOREMS for the exterminating unknown QUANTITIES in given EQUATIONS.*

In the following *Theorems*, we call those coefficients of the *same order* that are prefixed to the same unknown quantities in the different equations. Thus in *Theor.* 2d, *a, d, g*, are of the same order, being the coefficients of *x*: also *b, e, b*, are of the same order, being the coefficients of *y*: and those are of the same order that affect no unknown quantity.

But those are called *opposite* coefficients that are taken each from a different equation, and from a different order of coefficients: As, *a, e*, and *d, b*, in the first theorem; and *a, e, k*, in the second; also, *a, b, f*; and *d, b, k*, &c.

THEOREM I.

Suppose that two equations are given, involving two unknown quantities, as,

$$\begin{cases} ax+by=c \\ dx+ey=f \end{cases}$$

then shall  $y = \frac{af-dc}{ac-db}$ ;

where the numerator is the difference of the products of the opposite coefficients in the orders in which *y* is not found, and the denominator is the difference of the products of the opposite coefficients taken from the orders that involve the two unknown quantities.

For, from the first equation, it is plain, that

$$ax = c - by \dots \text{and } x = \frac{c-by}{a}$$

from the 2d,  $dx = f - ey \dots \text{and } x = \frac{f-ey}{d}$

therefore  $\frac{c-by}{a} = \frac{f-ey}{d}$ , and  $cd - dby = af - aey$

whence  $acy - dby = af - cd$ ,

and  $y = \frac{af-cd}{ac-db}$

after the same manner,  $x = \frac{cf-by}{ac-db}$

EXAMP. Supp.  $\begin{cases} 5x+7y=100 \\ 3x+8y=80 \end{cases}$

then  $y = \frac{5 \times 80 - 3 \times 100}{5 \times 8 - 3 \times 7} = \frac{100}{19} = 5 \frac{5}{19}$

and  $x = \frac{240}{19} = 12 \frac{12}{19}$

THEOREM II.

SUPPOSE now that there are three unknown quantities and three equations, then call the unknown quantities *x, y*, and *z*.

Thus,

$$\begin{cases} ax+by+cz=m \\ dx+ey+fz=n \\ gx+hy+kz=p \end{cases}$$

Then shall  $z = \frac{aep - ahn + dbm - dlp + gbn - gem}{a:k - ahf + dbc - dbk + gbf - gec}$ ;

where the numerator consists of all the different products that can be made of three opposite coefficients taken from the orders in which *z* is not found, and the denominator consists of all the products that can be made of the three opposite coefficients taken from the orders that involve the three unknown quantities.

CHAP. XII. *Of Quadratic EQUATIONS.*

In the solution of any question, where you have got an equation that involves one unknown quantity, but involves

volves at the same time the square of that quantity, and the product of it multiplied by some known quantity, then you have what is called a *Quadratic equation*; which may be resolved by the following

R U L E.

1. "Transport all the terms that involve the unknown quantity to one side, and the known terms to the other side of the equation.
2. "If the square of the unknown quantity is multiplied by any coefficient, you are to divide all the terms by that coefficient, that the coefficient of the square of the unknown quantity may be unit.
3. "Add to both sides the square of half the coefficient prefixed to the unknown quantity itself, and the side of the equation that involves the unknown quantity will then be a compleat square.
4. "Extract the square root from both sides of the equation; which you will find, on one side, always to be the unknown quantity, with half the foresaid coefficient subjoined to it; so that, by transposing this half, you may obtain the value of the unknown quantity expressed in known terms." Thus,

Suppose  $y^2 + ay = b$

Add the square of  $\frac{a}{2}$  to both sides  $\left. \begin{array}{l} y^2 + ay + \frac{a^2}{4} = b + \frac{a^2}{4} \end{array} \right\}$

Extract the root,  $y + \frac{a}{2} = \pm \sqrt{b + \frac{a^2}{4}}$

Transpose  $\frac{a}{2}$ ,  $y = \pm \sqrt{b + \frac{a^2}{4}} - \frac{a}{2}$

The square root of any quantity, as  $+aa$ , may be  $+a$ , or  $-a$ ; and hence, "All quadratic equations admit of two solutions." In the last example, after finding that  $y^2 + ay + \frac{a^2}{4} = b + \frac{a^2}{4}$ , it may be inferred that  $y + \frac{a}{2} = \pm \sqrt{b + \frac{a^2}{4}}$  or to  $-\sqrt{b + \frac{a^2}{4}}$ ; since  $-\sqrt{b + \frac{a^2}{4}} \times \sqrt{b + \frac{a^2}{4}}$  gives  $b + \frac{a^2}{4}$ , as well as  $+\sqrt{b + \frac{a^2}{4}} \times +\sqrt{b + \frac{a^2}{4}}$ . There are therefore two values of  $y$ ; the one gives  $y = +\sqrt{b + \frac{a^2}{4}} - \frac{a}{2}$ , the other,  $y = -\sqrt{b + \frac{a^2}{4}} - \frac{a}{2}$ .

Since the squares of all quantities are positive, it is plain that "the square root of a negative quantity is imaginary, and cannot be assigned." Therefore there are some quadratic equations that cannot have any solution. For example, suppose

$y^2 - ay + 3a^2 = 0$

then  $y^2 - ay = -3a^2$

add  $\frac{a^2}{4}$  to both,  $y^2 - ay + \frac{a^2}{4} = -3a^2 + \frac{a^2}{4}$

$= \frac{11a^2}{4}$

extract the root,  $y - \frac{a}{2} = \pm \sqrt{\frac{11a^2}{4}}$

and  $y = \frac{a}{2} \pm \sqrt{\frac{11a^2}{4}}$

whence the two values of  $y$  must be imaginary or impossible, because the root of  $-\frac{11a^2}{4}$  cannot possibly be assigned.

Suppose that the quadratic equation proposed to be resolved is  $y^2 - ay = b$

then  $y^2 - ay + \frac{a^2}{4} = b + \frac{a^2}{4}$

$y - \frac{a}{2} = \pm \sqrt{b + \frac{a^2}{4}}$

and  $y = \frac{a}{2} \pm \sqrt{b + \frac{a^2}{4}}$ . If the square root of

$b + \frac{a^2}{4}$  cannot be extracted exactly, you must, in order to determine the value of  $y$ , nearly approximate to the value of  $\sqrt{b + \frac{a^2}{4}}$ , by the rules in *chap. 7*. The following examples will illustrate the rule for quadratic equations.

EXAMP. I. "To find that number which if you multiply by the product shall be equal to the square of the same number having 12 added to it."

Call the number  $y$ , then

$y^2 + 12 = 8y$

transp.  $y^2 - 8y = -12$

add the Sq. of 4,  $y^2 - 8y + 16 = -12 + 16 = 4$

extract the R.  $y - 4 = \pm 2$

transp.  $y = 4 \pm 2 = 6$  or  $2$ .

EXAMP. II. "To find a number such, that if you subtract it from 10, and multiply the remainder by the number itself, the product shall give 21."

Call it  $y$ . Then

$(10 - y) \times y = 21$

that is,  $10y - yy = 21$

transp.  $y^2 - 10y = -21$

add the sq. of 5,  $y^2 - 10y + 25 = -21 + 25 = 4$

extract,  $y - 5 = \pm \sqrt{4} = \pm 2$

and  $y = 5 \pm 2 = 7$  or  $3$ .

EXAMP. III. "A company dining together in an inn, find their bill amounts to 175 shillings; two of them were not allowed to pay, and the rest found that their shares amounted to 10 s. a man more than if all had paid. *Qu.* How many were in company?"

Suppose their number  $x$ ; then if all had paid, each man's share would have been  $\frac{175}{x}$ ; but now the share of each person is  $\frac{175}{x-2}$ , seeing  $x-2$  is the number of those that pay. It is therefore, by the question,

$\frac{175}{x-2} - \frac{175}{x} = 10$ .

and  $175x - 175x + 350 = 10x^2 - 20x$

that is,  $10x^2 - 20x = 350$

and  $x^2 - 2x = 35$

add 1  $x^2 - 2x + 1 = 35 + 1 = 36$

extr.  $\sqrt{x-1} = \pm 6$

$x-1 = 6 = 7$ , or,  $-5$ .

It is obvious, that the positive value 7 gives the solution of the question; the negative value -5 being, in the present case, useless.

Any equation of this form  $y^m + ay^n = b$ , where the greatest index of the unknown quantity  $y$  is double to the index of  $y$  in the other term, may be reduced to a quadratic  $z^2 + az = b$ , by putting  $ym = z$ , and consequently  $y^m = z^2$ . And this quadratic resolved as above gives

$$z = -\frac{a}{2} \pm \sqrt{b + \frac{a^2}{4}}$$

And seeing  $y^m = z = -\frac{a}{2} \pm \sqrt{b + \frac{a^2}{4}}$ ,  $y =$

$$= \sqrt[m]{-\frac{a}{2} \pm \sqrt{b + \frac{a^2}{4}}}$$

EXAMP. "The product of two quantities is  $a$ , and the sum of their squares  $b$ . Qu. The quantities?"

Supp.  $\begin{cases} xy = a \dots \text{or } x = \frac{a}{y} \text{ and } x^2 = \frac{a^2}{y^2} \\ x^2 + y^2 = b \dots x^2 = b - y^2 \end{cases}$

whence  $b - y^2 = \frac{a^2}{y^2}$

mult. by  $y^2 \dots by^2 - y^4 = a^2$   
transp.  $y^4 - by^2 = -a^2$

Put now  $y^2 = z \dots$  and confeq.  $\dots y^4 = z^2$ , and it is  $z^2 - bz = -a^2$

add  $\frac{b^2}{4} \dots z^2 - bz + \frac{b^2}{4} = \frac{b^2}{4} - a^2$

ext.  $\sqrt{\dots} z - \frac{b}{2} = \pm \sqrt{\frac{b^2}{4} - a^2}$

and  $x = \frac{b}{2} \pm \sqrt{\frac{b^2}{4} - a^2}$  and, seeing  $y = \sqrt{x}$ ,

$$y = \pm \sqrt{\frac{b}{2} \pm \sqrt{\frac{b^2}{4} - a^2}}$$

CHAP. XIII. Of SURDS.

If a lesser quantity measures a greater so as to leave no remainder, as 2a measures 10a, being found in it five times, it is said to be an aliquot part of it, and the greater is said to be a multiple of the lesser. The lesser quantity in this case is the greatest common measure of the two quantities: for as it measures the greatest, so it also measures itself, and no quantity can measure it that is greater than itself.

When a third quantity measures any two proposed quantities, as 2a measures 6a and 10a, it is said to be a common measure of these quantities; and if no greater quantity measures them both, it is called their greatest common measure.

Those quantities are said to be commensurable which have any common measure; but if there can be no quantity found that measures them both, they are said to be incommensurable; and if any one quantity be called rational, all others that have any common measure with it, are also called rational: But those that have no common measure with it, are called irrational quantities.

If any two quantities  $a$  and  $b$  have any common measure  $x$ , this quantity  $x$  shall also measure their sum or difference  $a \pm b$ . Let  $x$  be found in  $a$  as many times as unit is found in  $m$ , so that  $a = mx$ , and in  $b$  as many times as unit is found in  $n$ , so that  $b = nx$ ; then shall  $a \pm b = mx \pm nx = (m \pm n)x$ ; so that  $x$  shall be found in  $a \pm b$ , as often as unit is found in  $m \pm n$ : now since  $m$  and  $n$  are integer numbers,  $m \pm n$  must be an integer number or unit, and therefore  $x$  must measure  $a \pm b$ .

It is also evident, that if  $x$  measure any number as  $a$ , it must measure any multiple of that number. If it be found in  $a$  as many times as unit is found in  $m$  so that  $a = mx$ , then it will be found in any multiple of  $a$ , as  $na$ , as many times as unit is found in  $mn$ ; for  $na = mnx$ .

If two quantities  $a$  and  $b$  are proposed, and  $b$  measure  $a$  by the units that are in  $m$  (that is, be found in  $a$  as many times as unit is found in  $m$ ) and there be a remainder  $c$ , and if  $x$  be supposed to be a common measure of  $a$  and  $b$ , it shall be also a measure of  $c$ . For by the supposition  $a = mb + c$ , since it contains  $b$  as many times as there are units in  $m$ , and there is  $c$  besides of remainder. Therefore  $a - mb = c$ . Now  $x$  is supposed to measure  $a$  and  $b$ , and therefore it measures  $mb$ , and consequently  $a - mb$ , which is equal to  $c$ .

If  $c$  measure  $b$  by the units in  $n$ , and there be a remainder  $d$ , so that  $b = nc + d$ , and  $b - nc = d$ , then shall  $x$  also measure  $d$ ; because it is supposed to measure  $b$ , and it has been proved that it measures  $c$ , and consequently  $nc$ , and  $b - nc$  which is equal to  $d$ . Whence, as, after subtracting  $b$  as often as possible from  $a$ , the remainder  $c$  is measured by  $x$ ; and, after subtracting  $c$  as often as possible from  $b$ , the remainder  $d$  is also measured by  $x$ ; so, for the same reason, if you subtract  $d$  as often as possible from  $c$ , the remainder (if there be any) must still be measured by  $x$ : and if you proceed, still subtracting every remainder from the preceding remainder, till you find some remainder, which, subtracted from the preceding, leaves no farther remainder, but exactly measures it, this last remainder will still be measured by  $x$ , any common measure of  $a$  and  $b$ .

The last of these remainders, viz. that which exactly measures the preceding remainder, must be a common measure of  $a$  and  $b$ : suppose that  $d$  was this last remainder, and that it measured  $c$  by the units in  $r$ , then shall  $c = rd$ , and we shall have these equations.

$$\begin{aligned} a &= mb + c \\ b &= nc + d \\ c &= rd. \end{aligned}$$

Now it is plain that since  $d$  measures  $c$ , it must also measure  $nc$ , and therefore must measure  $nc + d$ , or  $b$ . And since it measures  $b$  and  $c$ , it must measure  $mb + c$ , or  $a$ : so that it must be a common measure of  $a$  and  $b$ . But further, it must be their greatest common measure; for every common measure of  $a$  and  $b$  must measure  $d$ , by the last article; and the greatest number that measures  $d$ , is itself, which therefore is the greatest common measure of  $a$  and  $b$ .

But if, by continually subtracting every remainder from the preceding remainder, you can never find one that measures that which precedes it exactly, no quantity can be

be found that will measure both  $a$  and  $b$ ; and therefore they will be *incommensurable* to each other.

For if there was any common measure of these quantities, as  $x$ , it would necessarily measure all the remainders  $c$ ,  $d$ , &c. For it would measure  $c - mb$ , or  $c$ , and consequently  $b - nc$ , or  $d$ , and so on; now these remainders decrease in such a manner, that they will necessarily become at length less than  $x$ , or any assignable quantity. For  $c$  must be less than  $\frac{1}{2}a$ ; because  $c$  is less than  $b$ , and therefore less than  $mb$ , and consequently less than  $\frac{1}{2}c + \frac{1}{2}mb$ , or  $\frac{1}{2}a$ . In like manner  $d$  must be less than  $\frac{1}{2}b$ ; for  $d$  is less than  $c$ , and consequently less than  $\frac{1}{2}d + \frac{1}{2}nc$ , or  $\frac{1}{2}b$ . The third remainder, in the same manner, must be less than  $\frac{1}{2}c$ , which is itself less than  $\frac{1}{4}a$ : Thus these remainders decrease, so that every one is less than the half of that which preceded it next but one. Now if from any quantity you take away more than its half, and from the remainder more than its half, and proceed in this manner, you will come at a remainder less than any assignable quantity. It appears therefore, that if the remainders  $c$ ,  $d$ , &c. never end, they will become less than any assignable quantity, as  $x$ , which therefore cannot possibly measure them, and therefore cannot be a common measure of  $a$  and  $b$ .

In the same way the greatest common measure of two numbers is discovered. Unit is a common measure of all integer numbers, and two numbers are said to be *prime* to each other when they have no greater common measure than unit; such as 9 and 25. Such always are the least numbers that can be assumed in any given proportion; for if these had any common measure, then the quotients that would arise by dividing them by that common measure would be in the same proportion, and, being less than the numbers themselves, these numbers would not be the least in the same proportion; against the supposition.

The least numbers in any proportion always measure any other numbers that are in the same proportion. Suppose  $a$  and  $b$  to be the least of all integer numbers in the same proportion, and that  $c$  and  $d$  are other numbers in that proportion, then will  $a$  measure  $c$ , and  $b$  measure  $d$ .

For if  $a$  and  $b$  are not aliquot parts of  $c$  and  $d$ , then they must contain the same number of the same kind of parts of  $c$  and  $d$ ; and therefore dividing  $a$  into parts of  $c$ , and  $b$  into an equal number of like parts of  $d$ , and calling one of the first  $m$ , and one of the latter  $n$ ; then as  $m$  is to  $n$ , so will the sum of all the  $m$ 's be to the sum of all the  $n$ 's; that is,  $m : n :: a : b$ , therefore  $a$  and  $b$  will not be the least in the same proportion; against the supposition. Therefore  $a$  and  $b$  must be aliquot parts of  $c$  and  $d$ . Hence we see that numbers which are prime to each other are the least in the same proportion; for if there were others in the same proportion less than them, these would measure them by the same number, which therefore would be their common measure against the supposition, for we supposed them to be prime to each other.

If two numbers  $a$  and  $b$  are prime to one another, and a third number  $c$  measures one of them  $a$ , it will be prime to the other  $b$ . For if  $c$  and  $b$  were not prime to

each other, they would have a common measure, which, because it would measure  $c$ , would also measure  $a$ , which is measured by  $c$ , therefore  $a$  and  $b$  would have a common measure, against the supposition.

If two numbers  $a$  and  $b$  are prime to  $c$ , then shall their product  $ab$  be also prime to  $c$ : For if you suppose them to have any common measure as  $d$ , and suppose that  $d$  measures  $ab$  by the units in  $c$ , so that  $dc = ab$ , then shall  $d : a :: b : c$ . But since  $d$  measures  $c$ , and  $c$  is supposed to be prime to  $a$ , it follows that  $d$  and  $a$  are prime to each other; and therefore  $d$  must measure  $b$ ; and yet, since  $d$  is supposed to measure  $c$  which is prime to  $b$ , it follows that  $d$  is also prime to  $b$ ; that is,  $d$  is prime to a number which it measures, which is absurd.

It follows from the last article, that if  $a$  and  $c$  are prime to each other, then  $a^2$  will be prime to  $c$ : For by supposing that  $a$  is equal to  $b$ , then  $ab$  will be equal to  $a^2$ ; and consequently  $a^2$  will be prime to  $c$ . In the same manner  $c^2$  will be prime to  $a$ .

If two numbers  $a$  and  $b$  are both prime to other two  $c$ ,  $d$ , then shall the product  $ab$  be prime to the product  $cd$ ; for  $ab$  will be prime to  $c$  and also to  $d$ , and therefore, by the same article,  $cd$  will be prime to  $ab$ .

From this it follows, that if  $a$  and  $c$  are prime to each other, then shall  $a^2$  be prime to  $c^2$ , by supposing, in the last, that  $a = b$ , and  $c = d$ . It is also evident that  $a^2$  will be prime to  $c^3$ , and in general any power of  $a$  to any power of  $c$  whatsoever.

Any two numbers,  $a$  and  $b$ , being given, to find the least numbers that are in the same proportion with them, divide them by their greatest common measure  $x$ , and the quotients  $c$  and  $d$  shall be the least numbers in the same proportion with  $a$  and  $b$ .

For if there could be any other numbers in that proportion less than  $c$  and  $d$ , suppose them to be  $e$  and  $f$ , and these being in the same proportion as  $a$  and  $b$  would measure them: And the number by which they would measure them, would be greater than  $x$ , because  $e$  and  $f$  are supposed less than  $c$  and  $d$ , so that  $x$  would not be the greatest common measure of  $a$  and  $b$ ; against the supposition.

Let it be required to find the least number that any two given numbers, as  $a$  and  $b$ , can measure. First, "If they are prime to each other, then their product  $ab$  is the least number which they can both measure."

For if they could measure a less number than  $ab$  as  $c$ , suppose that  $c$  is equal to  $ma$ , and to  $nb$ ; and since  $c$  is less than  $ab$ , therefore  $ma$  will be less than  $ab$ , and  $nb$  less than  $b$ ; and  $nb$  being less than  $ab$ , it follows that  $n$  must be less than  $a$ ; but since  $ma = nb$ , and consequently  $a : b :: n : m$ , and  $a$  and  $b$  are prime to each other, it would follow that  $a$  would measure  $n$ , and  $b$  measure  $m$ , that is, a greater number would measure a less, which is absurd.

But if the numbers  $a$  and  $b$  are not prime to each other, and their greatest common measure is  $x$ , which measures  $a$  by the units in  $m$ , and measures  $b$  by the units in  $n$ , so that  $a = mx$ , and  $b = nx$ , then shall  $an$  (which is equal to  $bn$ , because  $a : b :: mx : nx :: m : n$ , and therefore  $an = bn$ ) be the least number that  $a$  and  $b$  can both measure. For if they could measure any number  $c$  less than

than  $na$ , so that  $c=la=kb$ , then  $a : b :: m : n :: k : l$ ; and because  $x$  is supposed to be the greatest common measure of  $a$  and  $b$ , it follows that  $m$  and  $n$  are the least of all numbers in the same proportion, and therefore  $m$  measures  $k$ , and  $n$  measures  $l$ . But as  $c$  is supposed to be less than  $na$ , that is,  $la$  less than  $na$ , therefore  $l$  is less than  $n$ , so that a greater would measure a lesser, which is absurd. Therefore  $a$  and  $b$  cannot measure any number less than  $an$ ; which they both measure, because  $ac=mb$ .

It follows from this reasoning, that if  $a$  and  $b$  measure any quantity  $c$ , the least quantity  $na$ , which is measured by  $a$  and  $b$ , will also measure  $c$ . For if you suppose, as before, that  $c=la$ , you will find, that  $n$  must measure  $l$ , and  $na$  must measure  $la$  or  $c$ .

Let  $a$  express any integer number, and  $\frac{m}{n}$  any fraction reduced to its lowest terms, so that  $m$  and  $n$  may be prime to each other, and consequently  $an+m$  also prime to  $n$ , it will follow that  $\frac{an+m}{n}$  will be prime to  $n$ , and consequently  $\frac{an+m}{n^2}$  will be a fraction in its least terms, and can never be equal to an integer number. Therefore the square of the mixt number  $a+\frac{m}{n}$  is still a mixt number, and never an integer. In the same manner, the cube, biquadrate, or any power of a mixt number, is still a mixt number, and never an integer. It follows from this, that the square root of an integer must be an integer or an incommensurable. Suppose that the integer proposed is  $B$ , and that the square root of it is less than  $a+1$ , but greater than  $a$ , then it must be an incommensurable; for if it is a commensurable, let it be  $a+\frac{m}{n}$  where  $\frac{m}{n}$  represents any fraction reduced to its least terms; it would follow, that  $a+\frac{m}{n}$  squared would give an integer number  $B$ , the contrary of which we have demonstrated.

It follows from the last article, that the square roots of all numbers but of 1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, &c. (which are the squares of the integer numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, &c.) are incommensurables: after the same manner, the cube roots of all numbers but of the cubes of 1, 2, 3, 4, 5, 6, 7, 8, 9, &c. are incommensurables; and quantities that are to one another in the proportion of such numbers must also have their square roots or cube roots incommensurable.

The roots of such numbers being incommensurable are expressed therefore by placing the proper radical sign over them; thus,  $\sqrt[3]{2}$ ,  $\sqrt[3]{3}$ ,  $\sqrt[3]{5}$ ,  $\sqrt[3]{6}$ ,  $\sqrt[3]{7}$ ,  $\sqrt[3]{8}$ ,  $\sqrt[3]{10}$ , &c. express numbers incommensurable with unit. These numbers, though they are incommensurable themselves with unit, are commensurable in power with it, because their powers are integers, that is, multiples of unit. They may also be commensurable sometimes with one another, as the  $\sqrt[3]{8}$ , and the  $\sqrt[3]{2}$ , because they are to one another as 2 to 1: And when they have

a common measure, as  $\sqrt[3]{2}$  is the common measure of both; then their ratio is reduced to an expression in the least terms, as that of commensurable quantities, by dividing them by their greatest common measure. This common measure is found as in commensurable quantities, only the root of the common measure is to be made their common divisor. Thus,  $\frac{\sqrt[3]{12}}{\sqrt[3]{3}} = \sqrt[3]{4} = 2$ , and

$$\frac{\sqrt[3]{18a}}{\sqrt[3]{2}} = 3\sqrt[3]{a}.$$

A rational quantity may be reduced to the form of any given surd, by raising the quantity to the power that is denominated by the name of the surd, and then setting the radical sign over it thus,  $a = \sqrt[3]{a^3} = \sqrt[4]{a^4} = \sqrt[5]{a^5} = \sqrt[n]{a^n}$ , and  $4 = \sqrt[3]{16} = \sqrt[4]{64} = \sqrt[5]{256} = \sqrt[6]{1024} = \sqrt[n]{4^n}$ .

As surds may be considered as powers with fractional exponents, "they are reduced to others of the same value that shall have the same radical sign, by reducing these fractional exponents to fractions having the same value and a common denominator." Thus,  $\sqrt[n]{a} = a^{\frac{1}{n}}$ ,  $\sqrt[m]{a} = a^{\frac{1}{m}}$ , and  $\frac{1}{n} = \frac{m}{nm}$ ,  $\frac{1}{m} = \frac{n}{nm}$ , and therefore  $\sqrt[n]{a}$  and  $\sqrt[m]{a}$ , reduced to the same radical sign, become  $\sqrt[nm]{a^m}$  and  $\sqrt[nm]{a^n}$ . If you are to reduce  $\sqrt[3]{3}$  and  $\sqrt[3]{2}$  to the same denominator, consider,  $\sqrt[3]{3}$  as equal to  $3^{\frac{1}{3}}$ , the  $\sqrt[3]{2}$  as equal to  $2^{\frac{1}{3}}$ , whose indices reduced to a common denominator, you have  $3^{\frac{2}{6}} = 3^{\frac{1}{3}}$  and  $2^{\frac{2}{6}} = 2^{\frac{1}{3}}$ , and consequently  $\sqrt[3]{3} = \sqrt[6]{27}$ , and  $\sqrt[3]{2} = \sqrt[6]{8}$ ; so that the proposed surds  $\sqrt[3]{3}$  and  $\sqrt[3]{2}$  are reduced to other equal surds  $\sqrt[6]{27}$  and  $\sqrt[6]{8}$ , having a common radical sign.

Surds of the same rational quantity are multiplied by adding their exponents, and divided by subtracting them;

$$\text{thus } \sqrt[3]{a} \times \sqrt[3]{a} = a^{\frac{1}{3}} \times a^{\frac{1}{3}} = a^{\frac{2}{3}} = \sqrt[3]{a^2}; \text{ and } \frac{\sqrt[3]{a}}{\sqrt[3]{a}} = \frac{a^{\frac{1}{3}}}{a^{\frac{1}{3}}} = a^{\frac{1}{3}-\frac{1}{3}} = a^0 = 1; \text{ and } \frac{\sqrt[3]{a^2}}{\sqrt[3]{a}} = a^{\frac{2}{3}-\frac{1}{3}} = a^{\frac{1}{3}} = \sqrt[3]{a};$$

$$\sqrt[m]{a} \times \sqrt[n]{a} = a^{\frac{m+n}{mn}}; \frac{\sqrt[m]{a}}{\sqrt[n]{a}} = a^{\frac{n-m}{mn}}; \sqrt[2]{2} \times \sqrt[3]{2} = \sqrt[6]{2^5} = \sqrt[6]{32}; \frac{\sqrt[3]{2}}{\sqrt[3]{2}} = \sqrt[3]{1} = 1.$$

If the surds are of different rational quantities, as  $\sqrt[n]{a^2}$  and  $\sqrt[m]{b^3}$ , and have the same sign, "multiply these rational quantities into one another, or divide them

" them by one another, and set the common radical sign over their product or quotient." Thus,  $\sqrt[n]{a^2} \times \sqrt[n]{b^3} = \sqrt[n]{a^2 b^3}$ ;  
 $\sqrt[2]{2} \times \sqrt[2]{5} = \sqrt[2]{10}$ ;  
 $\sqrt[m]{\frac{a^4}{b^3}} = \frac{\sqrt[m]{a^4}}{\sqrt[m]{b^3}} = \sqrt[m]{\frac{a^4}{b^3}}$ ;

If the surds have not the same radical sign, " reduce them to such as shall have the same radical sign, and

" proceed as before,"  $\sqrt[m]{a} \times \sqrt[n]{b} = \sqrt[\frac{mn}{n}]{a^{\frac{m}{n}} b^{\frac{n}{m}}}$ ;  
 $\sqrt[\frac{m}{n}]{\frac{a}{x}} = \sqrt[\frac{mn}{n}]{\frac{a^{\frac{m}{n}}}{x^{\frac{m}{n}}}}$

$\sqrt[\frac{m}{x}]{a^n}$ ;  
 $\sqrt[2]{2} \times \sqrt[3]{4} = 2^{\frac{1}{2}} \times 4^{\frac{1}{3}} = 2^{\frac{1}{2}} \times 2^{\frac{2}{3}} = 2^{\frac{3}{6} + \frac{4}{6}} = 2^{\frac{7}{6}} = \sqrt[6]{2^7} = \sqrt[6]{128}$ .

If the surds have any rational coefficients, their product or quotient must be prefixed; thus,  $2\sqrt[3]{3} \times 5\sqrt[3]{6} = 10\sqrt[3]{18}$ .

The powers of surds are found as the powers of other quantities, " by multiplying their exponents by the index of the power required;" thus the square of  $\sqrt[3]{2}$  is  $2^{\frac{2}{3}} \times 2 = 2^{\frac{4}{3}} = \sqrt[3]{4}$ ; the cube of  $\sqrt[3]{5} = 5^{\frac{3}{3}} \times 3 = 5^3 = \sqrt[3]{125}$ . Or you need only, in involving surds, " raise the quantity under the radical sign to the power required, continuing the same radical sign; unless the index of that power is equal to the name of the surd, or a multiple of it, and in that case the power of the surd becomes " rational." Evolution is performed " by dividing the fraction which is the exponent of the surd by the name of the root required." Thus the square root of  $\sqrt[3]{a^4}$  is  $\sqrt[3]{a^2}$  or  $\sqrt[6]{a^4}$ .

The surd  $\sqrt[m]{a^n x} = a^{\frac{n}{m}} \sqrt[m]{x}$ ; and in like manner, if a power of any quantity of the same name with the surd divides the quantity under the radical sign without a remainder, as here  $a^m$  divides  $a^m x$ , and 25 the square of

5 divides 75 the quantity under the sign in  $\sqrt{75}$  without a remainder, then place the root of that power rationally before the sign, and the quotient under the sign, and thus the surd will be reduced to a more simple expression.

Thus,  $\sqrt{75} = 5\sqrt{3}$ ;  $\sqrt[3]{48} = \sqrt[3]{3 \times 16} = 2\sqrt[3]{3}$ ;  $\sqrt[3]{81} = \sqrt[3]{27 \times 3} = 3\sqrt[3]{3}$ .

When surds by the last article are reduced to their least expressions, if they have the same irrational part, they are added or subtracted, " by adding or subtracting their rational coefficients, and prefixing the sum or difference to the common irrational part." Thus,  $\sqrt{75} + \sqrt{48} = 5\sqrt{3} + 4\sqrt{3} = 9\sqrt{3}$ ;  $\sqrt{81} + \sqrt{24} = 3\sqrt{3} + 2\sqrt{3} = 5\sqrt{3}$ .

Compound surds are such as consist of two or more joined together. The simple surds are commensurable in power, and by being multiplied into themselves give at length rational quantities; yet compound surds multiplied into themselves commonly give still irrational prod-

ucts. But when any compound surd is proposed, there is another compound surd which multiplied into it gives a rational product. Thus,  $\sqrt{a} + \sqrt{b}$  multiplied by  $\sqrt{a} - \sqrt{b}$  gives  $a - b$ , and " the investigation of that surd which multiplied into the proposed surd will give a " rational product," is made easy by the following theorems.

**THEOREM I.**

Generally, if you multiply  $a^m - b^m$  by  $a^{n-m} + a^{n-2m}b^m + a^{n-3m}b^2m + a^{n-4m}b^3m$ , &c. continued till the terms be in number equal to  $\frac{n}{m}$ , the product shall be  $a^n - b^n$ ; for

$$\begin{aligned} &a^{n-m} + a^{n-2m}b^m + a^{n-3m}b^2m + a^{n-4m}b^3m, \text{ \&c.} \dots b^{n-m} \\ &\times a^m - b^m \\ \hline &a^n + a^{n-m}b^m + a^{n-2m}b^2m + a^{n-3m}b^3m, \text{ \&c.} \\ &- a^{n-1m}b^m - a^{n-2m}b^2m - a^{n-3m}b^3m, \text{ \&c.} \\ \hline &a^n \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad - b^n \end{aligned}$$

**THEOREM II.**

$a^{n-m} - a^{n-2m}b^m + a^{n-3m}b^2m - a^{n-4m}b^3m$ , &c. multiplied by  $a^m + b^m$  gives  $a^n - b^n$ , which is demonstrated as the other. Here the sign of  $b^n$  is positive, when  $\frac{n}{m}$  is an odd number.

When any binomial surd is proposed, " suppose the index of each number equal to  $m$ , and let  $n$  be the least integer number that is measured by  $m$ , then shall "  $a^{n-m} - a^{n-2m}b^m + a^{n-3m}b^2m$ , &c. give a compound " surd, which multiplied into the proposed surd  $a^m + b^m$  " will give a rational product." Thus to find the surd

which multiplied by  $\sqrt[3]{a} - \sqrt[3]{b}$ , will give a rational quantity. Here  $m = \frac{1}{3}$ , and the least number which is measured by  $\frac{1}{3}$  is unit; let  $n = 1$ , then shall  $a^{n-m} + a^{n-2m}b^m + a^{n-3m}b^2m$ , &c.  $= a^{1-\frac{1}{3}} + a^{1-\frac{2}{3}}b^{\frac{1}{3}} + a^0b^{\frac{2}{3}} = a^{\frac{2}{3}} + a^{\frac{1}{3}}b^{\frac{1}{3}} + b^{\frac{2}{3}} = \sqrt[3]{a^2} + \sqrt[3]{ab} + \sqrt[3]{b^2}$ , which multiplied by  $\sqrt[3]{a} - \sqrt[3]{b}$  gives  $a - b$ .

To find the surd which multiplied by  $\sqrt[4]{a^3} + \sqrt[4]{b^3} = a^{\frac{3}{4}} + b^{\frac{3}{4}}$ , gives a rational product. Here  $m = \frac{1}{4}$  and  $n = 3$ , and  $a^{n-m} - a^{n-2m}b^m + a^{n-3m}b^2m$ , &c.  $= a^{3-\frac{1}{4}} - a^{3-\frac{2}{4}}b^{\frac{1}{4}} - a^{3-\frac{3}{4}}b^{\frac{2}{4}} = a^{\frac{11}{4}} - a^{\frac{5}{4}}b^{\frac{1}{4}} - a^{\frac{9}{4}}b^{\frac{2}{4}} = \sqrt[4]{a^{11}} - a^{\frac{5}{4}}\sqrt[4]{b} - a^{\frac{9}{4}}\sqrt[4]{b^2} = \sqrt[4]{a^3} - \sqrt[4]{a^5b} + \sqrt[4]{a^9b^2} - \sqrt[4]{b^3}$ .

**THEOREM III.**

Let  $a^m + b^m$  be multiplied by  $a^{n-m} - a^{n-2m}b^m + a^{n-3m}b^2m - a^{n-4m}b^3m$ , and the product shall give  $a^n - b^n$ ; therefore  $n$  must be taken the least integer that shall give  $\frac{n}{m}$  also an integer.

Dem.

Dem.  $a^m \pm a^{m-2}mb^2 + a^{m-4}mb^4 + \dots$

$$\frac{x a^{m-1} b^1 + \dots \&c. a^0 b^m}{a^m \pm a^{m-2}mb^2 + a^{m-4}mb^4, \&c.}$$

$$\frac{\pm a^{m-2}mb^2 - a^{m-4}mb^4 \&c. \pm b^m}{a^m \dots \dots \dots \pm b^m}$$

The sign of  $b^m$  is positive only when  $m$  is an odd number, and the binomial proposed is  $a^m + b^l$ .

If any binomial furd is proposed whose two numbers have different indices, let these be  $m$  and  $l$ , and take  $n$  equal to the least integer number that is measured by  $m$  and by  $l$ ; and  $a^m \pm a^{m-2}mb^2 + a^{m-4}mb^4 + \dots$  &c. shall give a compound furd, which multiplied by the proposed  $a^m \pm b^l$  shall give a rational product. Thus  $\sqrt[3]{a} - \sqrt[3]{b}$  being given, suppose  $m=3$ ,  $l=3$ , and  $\frac{m}{l}=1$ , therefore you have  $n=3$ , and

$$a^{m-2}mb^2 + a^{m-4}mb^4 + a^{m-6}mb^6 + \dots = a^{3-2}b^2 + a^{3-4}b^4 + \dots = a^{-1}b^2 + a^{-2}b^4 + \dots$$

$$a^3 - 1b^3 + a^3 - 2b^3 + a^3 - 3b^3 + \dots = a^3 - 3a^2b + 3ab^2 - b^3 = (a-b)^3$$

By these theorems any binomial furd whatsoever being given, you may find a furd which multiplied by it shall give a rational product.

Suppose that a binomial furd was to be divided by another, as  $\sqrt{20} + \sqrt{12}$ , by  $\sqrt{5} - \sqrt{3}$ , the quotient may be expressed by  $\frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}}$ . But it may be expressed in a more simple form by multiplying both numerator and denominator by that furd which, multiplied into the denominator, gives a rational product: Thus

$$\frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}} = \frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}} \times \frac{\sqrt{5} + \sqrt{3}}{\sqrt{5} + \sqrt{3}} = \frac{\sqrt{100} + 2\sqrt{60} + 6}{5 - 3} = \frac{16 + 2\sqrt{60}}{2} = 8 + \sqrt{15}$$

In general, when any quantity is divided by a binomial furd, as  $a^m \pm b^l$ , where  $m$  and  $l$  represent any fractions whatsoever, take  $n$  the least integer number that is measured by  $m$  and  $l$ , multiply both numerator and denominator by  $a^{n-m} \pm a^{n-2}mb^2 + a^{n-3}mb^3, \&c.$  and the denominator of the product will become rational, and equal to  $a^n - b^n$ ; then divide all the members of the numerator by this rational quantity, and the quoti-

ent arising will be that of the proposed quantity divided by the binomial furd, expressed in its least terms. Thus,

$$\frac{3}{\sqrt{5} - \sqrt{2}} = \frac{3\sqrt{5} + 3\sqrt{2}}{3} = \sqrt{5} + \sqrt{2};$$

$$\frac{\sqrt{6}}{\sqrt{7} - \sqrt{3}} = \frac{\sqrt{42} + \sqrt{18}}{4}$$

When the square root of a furd is required, it may be found nearly by extracting the root of a rational quantity that approximates to its value. Thus to find the square root of  $3 + 2\sqrt{2}$ , we first calculate  $\sqrt{2} = 1, 41421$ ; and therefore  $3 + 2\sqrt{2} = 5, 82842$ , whose root is found

to be nearly 2, 41421: So that  $\sqrt{3 + 2\sqrt{2}}$  is nearly 2, 41421. But sometimes we may be able to express the roots of furds exactly by other furds; as in this example the square root of  $3 + 2\sqrt{2}$  is  $1 + \sqrt{2}$ , for  $1 + \sqrt{2} \times 1 + \sqrt{2} = 1 + 2\sqrt{2} + 2 = 3 + 2\sqrt{2}$ .

In order to know when and how this may be found, let us suppose that  $x + y$  is a binomial furd, whose square will be  $x^2 + y^2 + 2xy$ : If  $x$  and  $y$  are quadratic furds, then  $x^2 + y^2$  will be rational, and  $2xy$  irrational; so that  $2xy$  shall always be less than  $x^2 + y^2$ , because the difference is  $x^2 + y^2 - 2xy = (x - y)^2$  which is always positive. Suppose that a proposed furd consisting of a rational part  $A$ , and an irrational part  $B$ , coincides with this, then  $x^2 + y^2 = A$  and  $xy = \frac{1}{2}B$ : Therefore by what was said of equations, Chap. 12th,

$$y^2 = A - x^2 = \frac{B^2}{4x^2}, \text{ and therefore,}$$

$$Ax^2 - x^4 = \frac{B^2}{4} \text{ and } x^4 - Ax^2 + \frac{B^2}{4} = 0;$$

from whence we have  $x^2 = \frac{A + \sqrt{A^2 - B^2}}{2}$  and  $y^2 =$

$\frac{A - \sqrt{A^2 - B^2}}{2}$ . Therefore when a quantity partly rational, partly irrational, is proposed to have its root extracted, call the rational part  $A$ , the irrational  $B$ , and the square of the greatest member of the root shall be  $\frac{A + \sqrt{A^2 - B^2}}{2}$ , and the square of the lesser part shall

be  $\frac{A - \sqrt{A^2 - B^2}}{2}$ . And as often as the square root of  $A^2 - B^2$  can be extracted, the square root of the proposed binomial furd may be expressed itself as a binomial furd. For example, if  $3 + 2\sqrt{2}$  is proposed, then  $A=3$ ,  $B=2\sqrt{2}$  and  $A^2 - B^2 = 9 - 8 = 1$ .

Therefore  $x^2 = \frac{A + \sqrt{A^2 - B^2}}{2} = 2$ , and  $y^2 = \frac{A - \sqrt{A^2 - B^2}}{2} = 1$ . Therefore  $x + y = 1 + \sqrt{2}$ .

To find the square root of  $-1 + \sqrt{-8}$ , suppose  $A = -1$ ,  $B = \sqrt{-8}$ , so that  $A^2 - B^2 = 9$  and  $\frac{A + \sqrt{A^2 - B^2}}{2} = \frac{-1 + 3}{2} = 1$ , and  $\frac{A - \sqrt{A^2 - B^2}}{2} = \frac{-1 - 3}{2} = -2$ , therefore the root required is  $1 + \sqrt{-2}$ .

But

But though  $x$  and  $y$  are not quadratic surds or roots of integers, if they are the roots of like surds, as if they are equal to  $\sqrt{m}\sqrt{z}$  and  $\sqrt{n}\sqrt{z}$ , where  $m$  and  $n$  are integers, then  $A = m + n \times \sqrt{z}$  and  $\frac{1}{2}B = \sqrt{mnz}$ ;  $A^2 - B^2 = (m-n)^2 \times z$  and  $x^2 = \frac{A + \sqrt{A^2 - B^2}}{2} = \frac{m+n \times z + m-n}{2} \times z = m\sqrt{z}$ ,  $y^2 = \frac{A - \sqrt{A^2 - B^2}}{2} = \frac{m+n \times z + m-n}{2} \times z = n\sqrt{z}$ , and  $x+y = \sqrt{m}\sqrt{z} + \sqrt{n}\sqrt{z}$ . The part  $A$  here easily distinguishes itself from  $B$  by its being greater.

If  $x$  and  $y$  are equal to  $\sqrt{m}\sqrt{z}$  and  $\sqrt{n}\sqrt{t}$ , then  $x^2 + 2xy + y^2 = m\sqrt{z} + n\sqrt{t} + 2\sqrt{mn}\sqrt{zt}$ . So that if  $z$  or  $t$  be not multiples one of the other, or of some number that measures them both by a square number, then will  $A$  itself be a binomial.

Let  $x+y+z$  express any trinomial surd, its square  $x^2 + y^2 + z^2 + 2xy + 2xz + 2yz$  may be supposed equal to  $A+B$  as before. But rather multiply any two radicals as  $2xy$  by  $2xz$ , and divide by the third  $2yz$  which gives the quotient  $2x^2$  rational, and double the square of the surd  $x$  required. The same rule serves when there are four quantities  $x^2 + y^2 + z^2 + t^2 + 2xy + 2xz + 2yz + 2ys + 2zt$ , multiply  $2xy$  by  $2xz$ , and the product  $4x^2yz$  divided by  $2yz$  gives  $2x^2$  a rational quotient, half the square of  $2x$ . In like manner  $2xy \times 2yz = 4y^2xz$ , which divided by  $2xz$  another member gives  $2y^2$ , a rational quote, the half of the square of  $2y$ . In the same manner  $z$  and  $t$  may be found; and their sum  $x+y+z+t$ , the square root of the septinomial  $x^2 + y^2 + z^2 + t^2 + 2xy + 2xz + 2yz + 2yt$ , discovered.

For example, to find the square root of  $10 + \sqrt{24} + \sqrt{40} + \sqrt{40} + \sqrt{60}$ ; I try  $\frac{\sqrt{24} \times \sqrt{40}}{\sqrt{60}}$  which I find to be  $\sqrt{16} = 4$ , the half of the square root of the double of which, viz.  $\frac{1}{2} \times \sqrt{8} = \sqrt{2}$ , is one member of the square root required; next  $\frac{\sqrt{24} \times \sqrt{60}}{\sqrt{40}} = 6$ , the half of the square root of the double of which is  $\sqrt{3}$  another member of the root required; lastly,  $\frac{\sqrt{40} \times \sqrt{60}}{\sqrt{24}} = 10$ , which gives  $\sqrt{5}$  for the third member of the root required: from which we conclude, that the square root of  $10 + \sqrt{24} + \sqrt{40} + 60$  is  $\sqrt{2} + \sqrt{3} + \sqrt{5}$ ; and trying, you find it succeeds, since multiplied by itself it gives the proposed quadrinomial.

For extracting the higher roots of a binomial, whose two members being squared are commensurable numbers, there is the following

**RULE.** " Let the quantity be  $A \pm B$ , whereof  $A$  is the greater part, and  $c$  the exponent of the root required. Seek the least number  $n$  whose power  $n^c$  is divisible by  $AA - BB$ , the quotient being  $Q$ .  
 " Compute  $\sqrt[A+B]{\sqrt{Q}}$  in the nearest integer number, which suppose to be  $r$ . Divide  $A\sqrt{Q}$  by its greatest rational divisor, and let the quotient be  $s$ ,  
 " and let  $\frac{r + \frac{n}{r}}$ , in the nearest integer number, be

"  $t$ , so shall the root required be  $\frac{r \pm \sqrt{r^2 - n}}{\sqrt[nc]{Q}}$ , if

" the  $c$  root of  $A \pm B$  can be extracted.

**EXAMP. I.** Thus to find the cube root of  $\sqrt{968} + 25$ , we have  $A^2 - B^2 = 343$ , whose divisors are 7, 7, 7, whence  $n=7$ , and  $Q=1$ . Further,  $\sqrt[A+B]{\sqrt{Q}}$ , that is,  $\sqrt[3]{968+25}$  is a little more than 56, whose nearest cube root is 4. Wherefore  $r=4$ . Again, dividing  $\sqrt[3]{968}$  by its greatest rational divisor, we have  $A\sqrt{Q} = 22\sqrt{2}$ , and the radical part  $\sqrt{2}=t$ , and  $\frac{r + \frac{n}{r}}{2}$ , or  $\frac{5}{2\sqrt{2}}$ , in the nearest integers, is  $2=t$ . And lastly,  $ts = 2\sqrt{2}$ ,  $\sqrt{t^2s^2 - n} = 1$ , and  $\sqrt[nc]{Q} = \sqrt[3]{1} = 1$ . Whence  $2\sqrt{2} + 1$  is the root, whose cube, upon trial, I find to be  $\sqrt[3]{968} + 25$ .

**EXAMP. II.** To find the cube root of  $68 - \sqrt{4374}$ , we have  $A^2 - B^2 = 250$ , whose divisors are 5, 5, 5, 2. Thence  $n=5 \times 2 = 10$ , and  $Q=4$ , and  $\sqrt[A+B]{\sqrt{Q}}$ , or  $\sqrt[3]{68 + \sqrt{4374} \times 2}$  is nearly  $7=r$ ; again  $A\sqrt{Q}$ , or  $68 \times \sqrt{4} = 136 \times \sqrt{1}$ , that is,  $s=1$ , and  $\frac{r + \frac{n}{r}}{2}$ , or  $\frac{7 + \frac{10}{7}}{2}$ , is nearly  $=4=t$ . Therefore  $ts=4$ ,  $\sqrt{t^2s^2 - n} = \sqrt{6}$ , and  $\sqrt[nc]{Q} = \sqrt[3]{4} = \sqrt{2}$ , whence the root to be tried is  $\frac{4 - \sqrt{6}}{\sqrt{2}}$ .

**CHAP. XIV. Of the GENESIS and RESOLUTION of EQUATIONS in general; and the number of Roots an Equation of any Degree may have.**

AFTER the same manner, as the higher powers are produced by the multiplication of the lower powers of the same root, equations of superior orders are generated by the multiplication of equations of inferior orders involving the same unknown quantity. And " an equation of any dimension may be considered as produced " by the multiplication of as many simple equations as " it has dimensions, or of any other equations what- " soever, if the sum of their dimensions is equal to the " dimension of that equation." Thus, any cubic equation may be conceived as generated by the multiplication of three simple equations, or of one quadratic and one simple equation. A biquadratic is generated by the multiplication of four simple equations, or of two quadratic equations, or, lastly, of one cubic and one simple equation.

If the equations which you suppose multiplied by one another are the same, then the equation generated will be nothing else but some power of those equations, and the operation is merely involuti. n; of which we have treated already: and, when any such equation is given, the simple equation by whose multiplication it is produced is found by evolution, or the extraction of a root.

But when the equations that are supposed to be multiplied



multiplied by each other are *different*, then other equations than powers are generated; which to resolve into the simple equations whence they are generated is a different operation from involution, and is, what is called, *the resolution of equations*.

But as evolution is performed by observing and tracing back the steps of involution; so to discover the rules for the resolution of equations, we must carefully observe their *generation*.

Suppose the unknown quantity to be  $x$ , and its values in any simple equations to be  $a, b, c, d$ , &c. then those simple equations, by bringing all the terms to one side, become  $x-a=0, x-b=0, x-c=0, \&c.$  And, the product of any two of these, as  $x-a \times x-b=0$  will give a quadratic equation, or an equation of two dimensions. The product of any three of them, as  $x-a \times x-b \times x-c=0$ , will give a *cubic* equation, or one of three dimensions. The product of any four of them will give a *biquadratic* equation, or one of four dimensions, as  $x-a \times x-b \times x-c \times x-d=0$ . And, in general, "in the equation produced, the highest dimension of the unknown quantity will be equal to the number of simple equations that are multiplied by each other."

When any equation, equivalent to this biquadratic  $x-a \times x-b \times x-c \times x-d=0$ , is proposed to be resolved, the whole difficulty consists in finding the simple equations  $x-a=0, x-b=0, x-c=0, x-d=0$ , by whose multiplication it is produced; for each of these simple equations gives one of the values of  $x$ , and one solution of the proposed equation. For, if any of the values of  $x$ , deduced from those simple equations, be substituted in the proposed equation in place of  $x$ , then all the terms of that equation will vanish, and the whole be found equal to nothing. Because, when it is supposed that  $x=a$ , or  $x=b$ , or  $x=c$ , or  $x=d$ , then the product  $x-a \times x-b \times x-c \times x-d$  does vanish, because one of the factors is equal to nothing. There are therefore four suppositions that give  $x-a \times x-b \times x-c \times x-d=0$  according to the proposed equation; that is, there are four roots of the proposed equation. And after the same manner, "any other equation admits of as many solutions as there are simple equations multiplied by one another that produce it, or, as many as there are units in the highest dimension of the unknown quantity in the proposed equation."

But as there are no other quantities whatsoever besides these four ( $a, b, c, d$ ) that substituted in the product  $x-a \times x-b \times x-c \times x-d$ , in the place of  $x$ , will make the product vanish; therefore the equation  $x-a \times x-b \times x-c \times x-d=0$ , cannot possibly have more than these four roots, and cannot admit of more solutions than four. If you substitute in that product a quantity neither equal to  $a$ , nor  $b$ , nor  $c$ , nor  $d$ , which suppose  $e$ , then since neither  $e-a, e-b, e-c$ , nor  $e-d$  is equal to nothing; their product  $e-a \times e-b \times e-c \times e-d$  cannot be equal to nothing, but must be some real product: and therefore there is no supposition beside one of the forefaid four that gives a just

value of  $x$  according to the proposed equation. So that it can have no more than these four roots. And after the same manner it appears, that "no equation can have more roots than it contains dimensions of the unknown quantity."

To make all this still plainer by an example, in numbers; suppose the equation to be resolved, to be  $x^4 - 10x^3 + 35x^2 - 50x + 24 = 0$ , and that you discover that this equation is the same with the product of  $x-1 \times x-2 \times x-3 \times x-4$ , then you certainly infer that the four values of  $x$  are 1, 2, 3, 4; seeing any of these numbers placed for  $x$  makes that product, and consequently  $x^4 - 10x^3 + 35x^2 - 50x + 24$ , equal to nothing, according to the proposed equation. And it is certain that there can be no other values of  $x$  besides these four: since when you substitute any other number for  $x$  in those factors  $x-1, x-2, x-3, x-4$ , none of the factors vanish; and therefore their product cannot be equal to nothing, according to the equation.

It may be useful sometimes to consider equations as generated from others of an inferior sort besides simple ones. Thus a *cubic* equation may be conceived as generated from the *quadratic*  $x^2 - px + q = 0$ , and the *simple* equation  $x-a=0$ , multiplied by each other; whose product

$$\left. \begin{aligned} x^3 - px^2 + qx - aq \\ - ax^2 + apx \end{aligned} \right\} = 0 \text{ may express any cubic equation whose roots are the quantity } (a) \text{ the value of } x \text{ in the simple equation, and the two roots of the quadratic equation, viz. } \frac{p + \sqrt{p^2 - 4q}}{2} \text{ and } \frac{p - \sqrt{p^2 - 4q}}{2};$$

as appears from Chap. 12. And, according as these roots are *real* or *impossible*, two of the roots of the cubic equation are *real* or *impossible*.

In the doctrine of involution, we shewed, that "the square of any quantity, positive or negative, is always positive;" and therefore "the square root of a negative is impossible or imaginary." For example, the  $\sqrt{a^2}$  is either  $+a$ , or  $-a$ ; but  $\sqrt{-a^2}$  can neither be  $+a$  nor  $-a$ , but must be *imaginary*. Hence is understood, that "a quadratic equation may have no possible expression in its coefficients; and yet, when it is resolved into the simple equations that produce it, they may involve impossible expressions." Thus, the quadratic equation  $x^2 + a^2 = 0$  has no impossible coefficient; but the simple equations from which it is produced, viz.  $x + \sqrt{-a^2} = 0$ , and  $x - \sqrt{-a^2} = 0$ , both involve an imaginary quantity; as the square  $-a^2$  is a real quantity, but its square root is imaginary. After the same manner, a biquadratic equation, when resolved, may give four simple equations, each of which may give an impossible value for the root: and the same may be said of any equation that can be produced from quadratic equations only, that is, whose dimensions are of the even numbers.

But, "a cubic equation (which cannot be generated from quadratic equations only, but requires one simple equation besides to produce it) if none of its coefficients are impossible, will have, at least, one real root," the same with the root of the simple equation

whence it is produced. The square of an impossible quantity may be real, as the square of  $\sqrt{-a^2}$  is  $-a^2$ ; but "the cube of an impossible quantity is still impossible," as it still involves the square root of a negative:

as,  $\sqrt{-a^2} \times \sqrt{-a^2} \times \sqrt{-a^2} = \sqrt{-a^2}^3 = a^3\sqrt{-1}$ , is plainly imaginary. From which it appears, that though two simple equations involving impossible expressions, multiplied by one another, may give a product where no impossible expression may appear; yet "if three such simple equations be multiplied by each other, the impossible expression will not disappear in their product." And hence it is plain, that though a quadratic equation whose coefficients are all real may have its two roots impossible, yet "a cubic equation whose coefficients are real cannot have all its three roots impossible."

In general, it appears, that the impossible expressions cannot disappear in the equation produced, but when their number is *even*; that there are never in any equations, whose coefficients are real quantities, single impossible roots, or an odd number of impossible roots, but "that the roots become impossible in pairs, and that an equation of an odd number of dimensions has always one real root."

"The roots of equations are either *positive* or *negative*, according as the roots of the simple equations whence they are produced are positive or negative." If you suppose  $x=-a$ ,  $x=-b$ ,  $x=-c$ ,  $x=-d$ , &c. then shall  $x+a=0$ ,  $x+b=0$ ,  $x+c=0$ ,  $x+d=0$ ; and the equation  $x+a \times x+b \times x+c \times x+d=0$  will have its roots,  $-a$ ,  $-b$ ,  $-c$ ,  $-d$ , &c. negative.

But to know when the roots of equations are positive, and when negative, and how many there are of each kind, shall be explained in the next chapter.

CHAP. XV. Of the SIGNS and COEFFICIENTS of Equations.

WHEN any number of simple equations are multiplied by each other, it is obvious that the highest dimension of the unknown quantity in their product is equal to the number of those simple equations; and the term involving the highest dimension is called the *first* term of the equation generated by this multiplication. The term involving the next dimension of the unknown quantity, less than the greatest by unit, is called the *second* term of the equation; the term involving the next dimension of the unknown quantity, which is less than the greatest by two, the *third* term of the equation, &c.; and that term which involves no dimension of the unknown quantity, but is some known quantity, is called the *last* term of the equation.

"The number of terms is always greater than the highest dimension of the unknown quantity by unit." And when any term is wanting, an asterisk is marked in its place. The signs and coefficients of equations will be understood by considering the following table, where the simple equations  $x=-a$ ,  $x=-b$ , &c. are multiplied by one another, and produce successively the higher equations.

$$\begin{array}{l} x-a=0 \\ x-x-b=0 \\ x^2-ax \\ -bx+ab \end{array} \left. \vphantom{\begin{array}{l} x-a=0 \\ x-x-b=0 \\ x^2-ax \\ -bx+ab \end{array}} \right\} = 0, \text{ a quadratic.}$$


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$$\begin{array}{l} x-x-c=0 \\ x^3-a \\ -b \\ -c \end{array} \left. \vphantom{\begin{array}{l} x-x-c=0 \\ x^3-a \\ -b \\ -c \end{array}} \right\} \begin{array}{l} +ab \\ +ac \\ +bc \end{array} \left. \vphantom{\begin{array}{l} +ab \\ +ac \\ +bc \end{array}} \right\} x^3-abc=0, \text{ a cubic.}$$


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$$\begin{array}{l} x-x-d=0 \\ x^4-a \\ -b \\ -c \\ -d \end{array} \left. \vphantom{\begin{array}{l} x-x-d=0 \\ x^4-a \\ -b \\ -c \\ -d \end{array}} \right\} \begin{array}{l} +ab \\ +ac \\ +ad \\ +bc \\ +bd \\ +cd \\ +ed \end{array} \left. \vphantom{\begin{array}{l} +ab \\ +ac \\ +ad \\ +bc \\ +bd \\ +cd \\ +ed \end{array}} \right\} \begin{array}{l} -abc \\ -abd \\ -acd \\ -bcd \end{array} \left. \vphantom{\begin{array}{l} -abc \\ -abd \\ -acd \\ -bcd \end{array}} \right\} x^4+abcd=0, \text{ a biqua-} \\ \text{dratic.} \end{array}$$


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$$\begin{array}{l} x-x-e=0 \\ x^5-a \\ -b \\ -c \\ -d \\ -e \end{array} \left. \vphantom{\begin{array}{l} x-x-e=0 \\ x^5-a \\ -b \\ -c \\ -d \\ -e \end{array}} \right\} \begin{array}{l} +ab \\ +ac \\ +ad \\ +ae \\ +bc \\ +bd \\ +cd \\ +ce \\ +de \end{array} \left. \vphantom{\begin{array}{l} +ab \\ +ac \\ +ad \\ +ae \\ +bc \\ +bd \\ +cd \\ +ce \\ +de \end{array}} \right\} \begin{array}{l} -abc \\ -abd \\ -abe \\ -acd \\ -ace \\ -bcd \\ -bce \\ -bde \\ -cde \end{array} \left. \vphantom{\begin{array}{l} -abc \\ -abd \\ -abe \\ -acd \\ -ace \\ -bcd \\ -bce \\ -bde \\ -cde \end{array}} \right\} x^5+abcde=0, \\ \text{(a sursolid.)} \end{array}$$

From the inspection of these equations it is plain, that the coefficient of the first term is *unit*.

The coefficient of the second term is the *sum of all the roots* ( $a, b, c, d, e$ ), *having their signs changed*.

The coefficient of the third term is the *sum of all the products that can be made by multiplying any two of the roots* ( $a, b, c, d, e$ ) *by one another*.

The coefficient of the fourth term is the *sum of all the products that can be made by multiplying into one another any three of the roots, with their signs changed*. And after the same manner all the other coefficients are formed.

The last term is always the *product of all the roots having their signs changed*, multiplied by one another.

Although in the table such simple equations only are multiplied by one another as have positive roots, it is easy to see, that "the coefficients will be formed according to the same rule when any of the simple equations have negative roots." And, in general, if  $x^3-px^2+qx-r=0$  represent any cubic equation, then shall  $p$  be the sum of the roots;  $q$  the sum of the products made by multiplying any two of them;  $r$  the product of all the three: and, if  $-p, +q, -r, +s, -t, +u, \&c.$  be the coefficients of the 2d, 3d, 4th, 5th, 6th, 7th, &c. terms of any equation, then shall  $p$  be the sum of all the roots,  $q$  the sum of the products of any two,  $r$  the sum of the products of any three,  $s$  the sum of the products of any four,  $t$  the sum of the products of any five,  $u$  the sum of the products of any six, &c.

When

When therefore any equation is proposed to be resolved, it is easy to find the sum of the roots. (for it is equal to the coefficient of the second term having its sign changed); or to find the sum of the products that can be made by multiplying any determinate number of them.

But it is also easy "to find the sum of the squares, or of any powers, of the roots.

The sum of the squares is always  $p^2 - 2q$ . For calling the sum of the squares  $B$ , since the sum of the roots is  $p$ ; and "the square of the sum of any quantities is always equal to the sum of their squares added to double the products that can be made by multiplying any two of them," therefore  $p^2 = B + 2q$ , and consequently  $B = p^2 - 2q$ . For example,  $(a+b+c)^2 = a^2 + b^2 + c^2 + 2ab + 2ac + 2bc$ ; that is,  $p^2 = B + 2q$ . And  $(a+b+c+d)^2 = a^2 + b^2 + c^2 + d^2 + 2 \times ab + ac + ad + bc + bd + cd$ , that is, again,  $p^2 = B + 2q$ , or  $B = p^2 - 2q$ . And so for any other number of quantities. In general therefore, " $B$  the sum of the squares of the roots may always be found by subtracting  $2q$  from  $p^2$ ;" the quantities  $p$  and  $q$  being always known, since they are the coefficients in the proposed equation.

"The sum of the cubes of the roots of any equation is equal to  $p^3 - 3pq + 3r$ , or to  $Bp - pq + 3r$ ." For  $B - q \times p$  gives always the excess of the sum of the cubes of any quantities above the triple sum of the products that can be made by multiplying any three of them. Thus,  $a^3 + b^3 + c^3 - ab - ac - bc \times a + b + c (= B - q \times p) = a^3 + b^3 + c^3 - 3abc$ . Therefore if the sum of the cubes is called  $C$ , then shall  $B - q \times p = C - 3r$ , and  $C = Bp - qp + 3r$  (because  $B = p^2 - 2q) = p^3 - 3pq + 3r$ .

After the same manner, if  $D$  be the sum of the 4th powers of the roots, you will find that  $D = pC - qB + pr - 4r$ , and if  $E$  be the sum of the 5th powers, then shall  $E = pD - qC + rB - pr + 5t$ . And after the same manner the sum of any powers of the roots may be found; the progression of these expressions of the sum of the powers being obvious.

As for the signs of the terms of the equation produced, it appears, from inspection, that the signs of all the terms in any equation in the table are alternately  $+$  and  $-$ : these equations are generated by multiplying continually  $x - a$ ,  $x - b$ ,  $x - c$ ,  $x - d$ , &c. by one another. The first term is always some pure power of  $x$ , and is positive; the second is a power of  $x$  multiplied by the quantities  $-a$ ,  $-b$ ,  $-c$ , &c. And since these are all negative, that term must therefore be negative. The third term has the products of any two of these quantities ( $-a$ ,  $-b$ ,  $-c$ , &c) for its coefficient; which products are all positive, because  $- \times -$  gives  $+$ . For the like reason, the next coefficient, consisting of all the products made by multiplying any three of these quantities must be negative, and the next positive. So that the coefficients, in this case, will be positive and negative by turns. But, "in this case the roots are all positive;" since  $x = a$ ,  $x = b$ ,  $x = c$ ,  $x = d$ ,  $x = e$ , &c. are the assumed simple equations. It is plain then, that "when all the roots are positive, the signs are alternately  $+$  and  $-$ ."

But if the roots are all negative, then  $x + a \times x + b \times$

$x + c \times x + d$ , &c.  $= 0$ . will express the equation to be produced; all whose terms will plainly be positive; so that, "when all the roots of an equation are negative, it is plain there will be no changes in the signs of the terms of that equation."

In general, "there are as many positive roots in any equation as there are changes in the signs of the terms from  $+$  to  $-$ , or from  $-$  to  $+$ ; and the remaining roots are negative." The rule is general, if the impossible roots be allowed to be either positive or negative; and may be extended to all kinds of equations.

In quadratic equations, the two roots are either both positive, as in this

$$(x - a \times x - b =) x^2 - ax + ab = 0,$$

where there are two changes of the signs: Or they are both negative, as in this

$$(x + a \times x + b =) x^2 + a \times x + ab = 0,$$

where there is not any change of the signs: Or there is one positive and one negative, as in

$$(x - a \times x + b =) x^2 - a \times x + b = 0,$$

where there is necessarily one change of the signs; because the first term is positive, and the last negative, and there can be but one change whether the 2d term be  $+$  or  $-$ .

Therefore the rule given in the last paragraph extends to all quadratic equations.

In cubic equations, the roots may be,

1°. All positive, as in this,  $x - a \times x - b \times x - c = 0$ , in which the signs are alternately  $+$  and  $-$ , as appears from the table; and there are three changes of the signs.

2°. The roots may be all negative, as in the equation  $x + a \times x + b \times x + c = 0$ , where there can be no change of the signs. Or,

3°. There may be two positive roots and one negative, as in the equation  $x - a \times x - b \times x + c = 0$ ; which gives

$$\left. \begin{matrix} x^3 - a \\ -b \\ +c \end{matrix} \right\} \left. \begin{matrix} +ab \\ x^2 - ac \\ -bc \end{matrix} \right\} x + abc = 0.$$

Here there must be two changes of the signs; because if  $a + b$  is greater than  $c$ , the second term must be negative, its coefficient being  $-a - b + c$ .

And if  $a + b$  is less than  $c$ , then the third term must be negative, its coefficient  $+ab - ac - bc (= ab - c \times a + b)$  being in that case negative. And there cannot possibly be three changes of the signs, the first and last terms having the same sign.

4°. There may be one positive root and two negative, as in the equation  $x + a \times x + b \times x - c = 0$ , which gives

$$\left. \begin{matrix} x^3 + a \\ +b \\ -c \end{matrix} \right\} \left. \begin{matrix} +ab \\ x^2 - ac \\ -bc \end{matrix} \right\} x - abc = 0.$$

where

\* Because the rectangle  $a \times b$  is less than the square  $a + b \times a + b$ , and therefore much less than  $a + b \times c$ .

where there must be always one change of the signs, since the first term is positive and the last negative. And there can be but one change of the signs, since if the 2d term is negative, or  $a+b$  less than  $c$ , the third must be negative also, so that there will be but one change of the signs. Or, if the second term is affirmative, whatever the third term is, there will be but one change of the signs. It appears therefore, in general, that in cubic equations, there are as many affirmative roots as there are changes of the signs of the terms of the equation.

There are several consecutaries of what has been already demonstrated, that are of use in discovering the roots of equations. But before we proceed to that, it will be convenient to explain some transformations of equations, by which they may often be rendered more simple, and the investigation of their roots more easy.

CHAP. XVI. *Of the Transformation of Equations; and exterminating their intermediate Terms.*

We now proceed to explain the transformation of equations that are most useful: and, first, "The affirmative roots of an equation are changed into negative roots of the same value, and the negative roots into affirmative, by only changing the signs of the terms alternately, beginning with the second." Thus, the roots of the equation  $x^4 - x^3 - 19x^2 + 49x - 30 = 0$  are  $+1, +2, +3, -5$ ; whereas the roots of the same equation having only the signs of the second and fourth terms changed, *viz.*  $x^4 + x^3 - 19x^2 + 49x - 30 = 0$  are  $-1, -2, -3, +5$ .

To understand the reason of this rule, let us assume an equation, as  $x - a \times x - b \times x - c \times x - d \times x - e$ , &c.  $= 0$ , whose roots are  $+a, +b, +c, +d, +e$ , &c. and another, having its roots of the same value, but affected with contrary signs, as  $+a \times x + b \times x + c \times x + d \times x + e$ , &c.  $= 0$ . It is plain, that the terms taken alternately, beginning from the first, are the same in both equations, and have the same sign, "being products of an even number of the roots;" the product of any two roots having the same sign as their product when both their signs are changed; as  $+a \times -b = -a \times +b$ .

But the second terms, and all taken alternately from them, because their coefficients involve always the products of an odd number of the roots, will have contrary signs in the two equations. For example, the product of four, *viz.*  $abcd$ , having the same sign in both, and one equation in the fifth term having  $abcd \times +e$ , and the other  $abcd \times -e$ , it follows, that their product  $abcde$  must have contrary signs in the two equations: these two equations therefore that have the same roots, but with contrary signs, have nothing different but the signs of the alternate terms, beginning with the second. From which it follows, "that if any equation is given, and you change the signs of the alternate terms, beginning with the second, the new equation will have roots of the same value, but with contrary signs."

It is often very useful "to transform an equation into

"another that shall have its roots greater or less than the roots of the proposed equation by some given difference."

Let the equation proposed be the cubic  $x^3 - px^2 + qx - r = 0$ . And let it be required to transform it into another equation whose roots shall be less than the roots of this equation by some given difference ( $e$ ), that is, suppose  $y = x - e$ , and consequently  $x = y + e$ ; then, instead of  $x$  and its powers, substitute  $y + e$  and its powers, and there will arise this new equation.

$$(A) \left. \begin{aligned} y^3 + 3ey^2 + 3e^2y + e^3 \\ - py^2 - 2pey - pe^2 \\ + y^2 + ye \\ - r \end{aligned} \right\} = 0,$$

whose roots are less than the roots of the preceding equation by the difference ( $e$ ).

If it had been required to find an equation whose roots should be greater than those of the proposed equation by the quantity ( $e$ ), then we must have supposed  $y = x + e$ , and consequently  $x = y - e$ , and then the other equation would have had this form.

$$(B) \left. \begin{aligned} y^3 - 3ey^2 + 3e^2y - e^3 \\ - py^2 + 2pey - pe^2 \\ + y^2 - ye \\ - r \end{aligned} \right\} = 0.$$

If the proposed equation be in this form  $x^3 + px^2 + qx + r = 0$ , then, by supposing  $x = y$ , there will arise an equation agreeing in all respects with the equation (A), but that the second and fourth terms will have contrary signs.

And by supposing  $x = -y$ , there will arise an equation agreeing with (B) in all respects, but that the second and fourth terms will have contrary signs to what they have in (B).

The first of these suppositions gives this equation,

$$(C) \left. \begin{aligned} y^3 - 3ey^2 + 3e^2y - e^3 \\ + py^2 - 2pey + pe^2 \\ + y^2 - ye \\ + r \end{aligned} \right\} = 0.$$

The second supposition gives the equation,

$$(D) \left. \begin{aligned} y^3 + 3ey^2 + 3e^2y + e^3 \\ + py^2 + 2pey + pe^2 \\ + y^2 + ye \\ + r \end{aligned} \right\} = 0.$$

The first use of this transformation of equations is to shew "how the second (or other intermediate) term may be taken away out of an equation."

It is plain, that in the equation (A) whose second term is  $3e - p \times y^2$ , if you suppose  $e = \frac{1}{3}p$ , and consequently  $3e - p = 0$ , then the second term will vanish.

In the equation (C) whose second term is  $-3e + p \times y^2$ , supposing  $e = \frac{1}{3}p$ , the second term also vanishes.

Now the equation (A) was deduced from  $x^3 - px^2 + qx - r = 0$ , by supposing  $y = x - e$ : and the equation (C) was deduced from  $x^3 + px^2 + qx + r = 0$ ; by supposing  $y = x + e$ . From which this rule may easily be deduced for exterminating the second term out of any cubic equation.

RULE.

**RULE.** Add to the unknown quantity of the given equation the third part of the coefficient of the second term with its proper sign, viz.  $\mp \frac{1}{3}p$ , and suppose this aggregate equal to a new unknown quantity ( $y$ ). From this value of  $y$  find a value of  $x$  by transposition, and substitute this value of  $x$  and its powers in the given equation, and there will arise a new equation that shall want the second term.

**EXAMP.** Let it be required to exterminate the second term out of this equation,  $x^3 - 9x^2 + 26x - 34 = 0$ , suppose  $x - 3 = y$ , or  $y + 3 = x$ ; and substituting according to the rule, you will find

$$\left. \begin{array}{r} y^3 + 9y^2 + 27y + 27 \\ - 9y^2 - 54y - 81 \\ + 26y + 78 \\ - 34 \end{array} \right\} = 0$$


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$$y^3 + y - 10 = 0.$$

In which there is no term where  $y$  is of two dimensions, and an asterisk is placed in the room of the 2d term, to shew it is wanting.

Let the equation proposed be of any number of dimensions represented by ( $n$ ); and let the coefficient of the second term with its sign prefixed be  $-p$ , then supposing  $x - \frac{p}{n} = y$ , and consequently  $x = y + \frac{p}{n}$ , and substituting this value for  $x$  in the given equation, there will arise a new equation that shall want the second term.

It is plain from what was demonstrated in chap. 15. that the sum of the roots of the proposed equation is  $+p$ ; and since we suppose  $y = x - \frac{p}{n}$ , it follows, that, in the new equation, each value of  $y$  will be less than the respective value of  $x$  by  $\frac{p}{n}$ ; and, since the number of the roots is  $n$ , it follows, that the sum of the values of  $y$  will be less than  $+p$ , the sum of the values of  $x$ , by  $n \times \frac{p}{n}$ , the difference of any two roots, that is, by  $+p$ ; therefore the sum of the values of  $y$  will be  $+p - p = 0$ .

But the coefficient of the second term of the equation of  $y$  is the sum of the values of  $y$ , viz.  $+p - p$ , and therefore that coefficient is equal to nothing; and consequently, in the equation of  $y$ , the second term vanishes. It follows then, that the second term may be exterminated out of any given equation by the following

**RULE.** Divide the coefficient of the second term of the proposed equation by the number of dimensions of the equation; and assuming a new unknown quantity  $y$ , add to it the quotient having its sign changed. Then suppose this aggregate equal to  $x$  the unknown quantity in the proposed equation; and for  $x$  and its powers, substitute the aggregate and its powers, so shall the new equation that arises want its second term.

If the proposed equation is a quadratic, as  $x^2 - px + q = 0$ , Vol. I. No. 5.

$= 0$ , then, according to the rule, suppose  $y + \frac{1}{2}p = x$ , and substituting this value for  $x$ , you will find,

$$\left. \begin{array}{r} y^2 + py + \frac{1}{4}p^2 \\ - py - \frac{1}{2}p^2 \\ + q \end{array} \right\} = 0,$$


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$$y^2 - \frac{1}{4}p^2 + q = 0.$$

And from this example the use of exterminating the 2d term appears: for commonly the solution of the equation that wants the 2d term is more easy. And, if you can find the value of  $y$  from this new equation, it is easy to find the value of  $x$ , by means of the equation  $y + \frac{1}{2}p = x$ . For example,

Since  $y^2 + q - \frac{1}{4}p^2 = 0$ , it follows, that  $y^2 = \frac{1}{4}p^2 - q$ , and  $y = \pm \sqrt{\frac{1}{4}p^2 - q}$ , so that  $x = y + \frac{1}{2}p = \frac{1}{2}p \pm \sqrt{\frac{1}{4}p^2 - q}$ ;

which agrees with what we demonstrated, chap. 12.

If the proposed equation is a biquadratic, as  $x^4 - px^3 + qx^2 - rx + s = 0$ , then, by supposing  $x - \frac{1}{2}p = y$  or  $x = y + \frac{1}{2}p$ , an equation shall arise having no second term. And if the proposed equation is of 5 dimensions, then you must suppose  $x = y + \frac{1}{5}p$ . And so on.

When the second term in any equation is wanting, it follows, that "the equation has both affirmative and negative roots," and that "the sum of the affirmative roots is equal to the sum of the negative roots:" by which means the coefficient of the 2d term, which is the sum of all the roots of both sorts, vanishes, and makes the second term vanish.

In general, "The coefficient of the 2d term is the difference between the sum of the affirmative roots and the sum of the negative roots:" and the operations we have given serve only to diminish all the roots when the sum of the affirmative is greatest, or increase the roots when the sum of the negative is greatest, so as to balance them, and reduce them to an equality.

It is obvious, that in a quadratic equation that wants the second term, there must be one root affirmative and one negative; and these must be equal to one another.

In a cubic equation that wants the second term, there must be either two affirmative roots equal, taken together to a third root that must be negative; or, two negative equal to a third that must be positive.

"Let an equation  $x^3 - px^2 + qx - r = 0$  be proposed, and let it be now required to exterminate the third term."

By supposing  $y = x - e$ , the coefficient of the 3d term in the equation of  $y$  is found (see equation A) to be  $3e^3 - 2pe + q$ . Suppose that coefficient equal to nothing, and by resolving the quadratic equation  $3e^2 - 2pe + q = 0$ , you will find the value of  $e$ , which substituted for it in the equation  $y = x - e$ , will shew how to transform the proposed equation into one that shall want the third term.

The quadratic  $3e^2 - 2pe + q = 0$ , gives  $e = \frac{p \pm \sqrt{p^2 - 3q}}{3}$ .

So that the proposed cubic will be transformed into an equation wanting the third term by supposing  $y = x -$

$$\frac{p - \sqrt{p^2 - 3q}}{3}, \text{ or } y = x - \frac{p + \sqrt{p^2 - 3q}}{3}$$

| D d

If the proposed equation is of  $n$  dimensions, the value of  $e$ , by which the 3d term may be taken away, is had by resolving the quadratic equation  $e^2 + \frac{2p}{n}Xe + \frac{2q}{n \times n - 1} = 0$ , supposing  $-p$  and  $+q$  to be the coefficients of the 2d and 3d terms of the proposed equation.

The 4th term of any equation may be taken away by solving a cubic equation, which is the coefficient of the 4th term in the equation when transformed, as in the former part of this chapter. The fifth term may be taken away by solving a biquadratic; and after the same manner the other terms can be exterminated if there are any.

There are other transmutations of equations that, on some occasions, are useful.

An equation, as  $x^3 - px^2 + qx - r = 0$ , "may be transformed into another that shall have its roots equal to the roots of this equation multiplied by a given quantity," as  $f$ , by supposing  $y = fx$ , and consequently  $x = \frac{y}{f}$ , and substituting this value for  $x$  in the proposed

equation, there will arise  $\frac{y^3}{f^3} - \frac{py^2}{f^2} + \frac{qy}{f} - r = 0$ , and multiplying all by  $f^3$ .  $y^3 - fpy^2 + f^2qy - f^3r = 0$ , where the coefficient of the 2d term of the proposed equation multiplied into  $f$ , makes the coefficient of the 2d term of the transformed equation; and the following coefficients are produced by the following coefficients of the proposed equation, (as  $q$ ,  $r$ , &c.) multiplied into the powers of  $f$  ( $f^2$ ,  $f^3$ , &c.).

Therefore "to transform any equation into another whose roots shall be equal to the roots of the proposed equation multiplied by a given quantity ( $f$ )," you need only multiply the terms of the proposed equation, beginning at the 2d term, by  $f$ ,  $f^2$ ,  $f^3$ ,  $f^4$ , &c. and putting  $y$  instead of  $x$ , there will arise an equation having its roots equal to the roots of the proposed equation multiplied by ( $f$ ) as required.

The transformation mentioned above is of use when the highest term of the equation has a coefficient different from unity. for, by it, the equation may be transformed into one that shall have the coefficient of the highest term unit.

If the equation proposed is  $ax^3 - px^2 + qx - r = 0$ , then transform the equation into one whose roots are equal to the roots of the proposed equation multiplied by ( $a$ ). That is, suppose  $y = ax$  or  $x = \frac{y}{a}$  and there will arise

$$\frac{y^3}{a^3} - \frac{py^2}{a^2} + \frac{qy}{a} - r = 0; \text{ so that } y^3 - py^2 + qay - ra^3 = 0.$$

From which we easily draw this

**RULE.** Change the unknown quantity  $x$  into another  $y$ , prefix no coefficient to the highest term, pass the 2d, multiply the following terms, beginning with the 3d, by  $a$ ,  $a^2$ ,  $a^3$ ,  $a^4$ , &c. the powers of the coefficient of the highest term of the proposed equation, respectively.

Thus the equation  $3x^3 - 13x^2 + 14x + 16 = 0$ , is trans-

formed into the equation  $y^3 - 13y^2 + 14xy + 16x^3 = 0$  or  $y^3 - 13y^2 + 42x + 144 = 0$ .

Then finding the roots of this equation, it will easily be discovered what are the roots of the proposed equation, since  $3x = y$ , or  $x = \frac{y}{3}$ . And therefore, since one of the values of  $y$  is  $-2$ , it follows, that one of the values of  $x$  is  $-\frac{2}{3}$ .

By the last rule, "an equation is easily cleared of fractions." Suppose the equation proposed is  $x^3 - \frac{p}{m}x^2 + \frac{q}{n}x - \frac{r}{c} = 0$ . Multiply all the terms by the product of the denominators, you find

$$mncx^3 - ncpXx^2 + meqXx - mnrc = 0.$$

Then (as above) transforming the equation into one that shall have unit for the coefficient of the highest term, you find

$$y^3 - ncpXy^2 + m^2c^2nqXy - m^3n^3c^2r = 0.$$

Or, neglecting the denominator of the last term  $\frac{r}{c}$  you need only multiply all the equation by  $mn$ , which will give

$$mnXx^3 - npXx^2 + mqXx - \frac{mnr}{c} = 0. \text{ And}$$

$$\text{then } y^3 - npXy^2 + m^2nqXy - \frac{m^3n^3r}{c} = 0.$$

Now after the values of  $y$  are found, it will be easy to discover the values of  $x$ ; since, in the first case,  $x = \frac{y}{mnc}$ ; in the second,  $x = \frac{y}{mn}$ .

For example, the equation

$$x^3 - \frac{4}{3}x - \frac{146}{9} = 0, \text{ is first reduced}$$

to this form  $3x^3 - 4x - 146 = 0$ , and then transformed into  $y^3 - 12y - 146 = 0$ .

Sometimes, by these transformations, "surds are taken away." As for example,

The equation  $x^3 - p\sqrt{a}x^2 + qx - r\sqrt{a} = 0$ , by putting  $y = \sqrt{a}x$ , or  $x = \frac{y}{\sqrt{a}}$ , is transformed into this equation,

$\frac{y^3}{a\sqrt{a}} - p\sqrt{a}\frac{y^2}{a} + q\frac{y}{\sqrt{a}} - r\sqrt{a} = 0$ . Which, by multiplying all the terms by  $a\sqrt{a}$ , becomes  $y^3 - pay^2 + qay - ra^2 = 0$ , an equation free of surds. But in order to make this succeed, the surd ( $\sqrt{a}$ ) must enter the alternate terms, beginning with the second:

"An equation, as  $x^3 - px^2 + qx - r = 0$ , may be transformed into one whose roots shall be the quantities reciprocal of  $x$ ;" by supposing  $y = \frac{1}{x}$ , and  $y = \frac{x}{r}$ , or

$$\text{(by one supposition), } x = \frac{r}{y}, \text{ becomes } x^3 - qx^2 + prx - r^3 = 0.$$

In the equation of  $y$ , it is manifest, that the order of the coefficients is inverted; so that, if the second term had been wanting in the proposed equation, the last but one should have been wanting in the equations of  $y$  and  $x$ . If the 3d had been wanting in the equation proposed, the last but two had been wanting in the equations of  $y$  and  $x$ .

Another use of this transformation is, that the great-

is not in the one is transformed into the least root in the other. For since  $x = \frac{1}{y}$ , and  $y = \frac{1}{x}$ , it is plain, that when the value of  $x$  is greatest, the value of  $y$  is least, and conversely.

How an equation is transformed so as to have all its roots affirmative, shall be explained in the following chapter.

CHAP. XVII. Of finding the ROOTS of Equations when two or more of the Roots are equal to each other.

§1. BEFORE we proceed to explain how to resolve equations of all sorts, we shall first demonstrate how an equation that has two or more roots equal, is depressed to a lower dimension; and its resolution made, consequently, more easy. And shall endeavour to explain the grounds of this and many other rules we shall give in the remaining part of this treatise, in a more simple and concise manner than has hitherto been done.

In order to this, we must look back to the last chapter, where we find, that if any equation, as  $x^3 - px^2 + qx - r = 0$ , is proposed, and you are to transform it into another that shall have its roots less than the values of  $x$  by any given difference, as  $e$ , you are to assume  $y = x - e$ , and substituting for  $x$  its value  $y + e$ , you find the transformed equation,

$$\left. \begin{aligned} y^3 + 3ey^2 + 3e^2y + e^3 \\ - py^2 - 2pey - pe^2 \\ + qy + qe \\ - r \end{aligned} \right\} = 0.$$

Where we are to observe,

1°. That the last term ( $e^3 - pe^2 + qe - r$ ) is the very equation that was proposed, having  $e$  in place of  $x$ .

2°. The coefficient of the last term but one is  $3e^2 - 2pe + q$ , which is the quantity that arises by multiplying every term of the last coefficient  $e^3 - pe^2 + qe - r$  by the index of  $e$  in each term, and dividing the product  $3e^3 - 2pe^2 + qe$  by the quantity  $e$  that is common to all the terms.

3°. The coefficient of the last term but two is  $3e - p$ , which is the quantity that arises by multiplying every term of the coefficient last found ( $3e^2 - 2pe + q$ ) by the index of  $e$  in each term, and dividing the whole by  $2e$ .

§2. These same observations extend to equations of all dimensions. If it is the biquadratic  $x^4 - px^3 + qx^2 - rx + s = 0$  that is proposed, then by supposing  $y = x - e$ , it will be transformed into this other,

$$\left. \begin{aligned} y^4 + 4ey^3 + 6e^2y^2 + 4e^3y + e^4 \\ - py^3 - 3pe^2y^2 - 3pe^3y - pe^4 \\ + qy^2 + 2qey + qe^2 \\ - ry - re \\ + s \end{aligned} \right\} = 0$$

Where again it is obvious, That the last term is the equation that was proposed, having  $e$  in place of  $x$ : That the last term but one has for its coefficient the quantity

that arises by multiplying the terms of the last quantity by the indices of  $e$  in each term, and dividing the product by  $e$ : That the coefficient of the last term but two, (*viz.*  $6e^2 - 3pe + q$ ) is deduced in the same manner from the term immediately following, that is, by multiplying every term of  $4e^3 - 3pe^2 + 2qe - r$  by the index of  $e$  in that term, and dividing the whole by  $e$  multiplied into the index of  $y$  in the term sought, that is, by  $e \times 2$ : And the next term is  $4e - p = \frac{6e^2 \times 2 - 3pe \times 1}{3e}$ .

The demonstration of this may easily be made general by the theorem for finding the powers of a binomial, since the transformed equation consists of the powers of the binomial  $y + e$  that are marked by the indices of  $e$  in the last term, multiplied each by their coefficients 1,  $-p$ ,  $+q$ ,  $-r$ ,  $+s$ , &c. respectively.

§3. From the last two articles we can easily find the terms of the transformed equation without any involution. The last term is had by substituting  $e$  instead of  $x$  in the proposed equation; the next term, by multiplying every part of that last term by the index of  $e$  in each part, and dividing the whole by  $e$ ; and the following terms in the manner described in the foregoing article; the respective divisors being the quantity  $e$  multiplied by the index of  $y$  in each term.

The demonstration for finding when two or more roots are equal will be easy, if we add to this, that "when the unknown quantity enters all the terms of any equation, then one of its values is equal to nothing." As in the equation  $x^3 - px^2 + qx = 0$ , where  $x = 0 = 0$  being one of the simple equations that produce  $x^3 - px^2 + qx = 0$ , it follows that one of the values of  $x$  is 0. In like manner, two of the values of  $x$  are equal to nothing in this equation  $x^3 - px^2 = 0$ ; and three of them vanish in the equation  $x^4 - px^3 = 0$ .

It is also obvious (*conversely*) that "if  $x$  does not enter all the terms of the equation, *i. e.* if the last term be not wanting, then none of the values of  $x$  can be equal to nothing," for if every term be not multiplied by  $x$ , then  $x = 0$  cannot be a divisor of the whole equation, and consequently 0 cannot be one of the values of  $x$ . If  $x^2$  does not enter into all the terms of the equation, then two of the values of  $x$  cannot be equal to nothing. If  $x^3$  does not enter into all the terms of the equation, then three of the values of  $x$  cannot be equal to nothing, &c.

§4. Suppose now that two values of  $x$  are equal to one another, and to  $e$ ; then it is plain that two values of  $y$  in the transformed equation will be equal to nothing: since  $y = -e$ . And consequently, by the last article, the two last terms of the transformed equation must vanish.

Suppose it is the cubic equation of § 1. that is proposed, *viz.*  $x^3 - px^2 + qx - r = 0$ ; and because we suppose  $x = e$ , therefore the last term of the transformed equation, *viz.*  $e^3 - pe^2 + qe - r$  will vanish. And since two values of  $y$  vanish, the last term but one, *viz.*  $3e^2y - 2pey + qy$  will vanish at the same time. So that  $3e^2 - 2pe + q = 0$ . But, by supposition,  $e = x$ ; therefore, when two values of  $x$ , in the equation,  $x^3 - px^2 + qx - r = 0$ , are equal, it follows, that  $3x^2 - 2px + q = 0$ . And thus,

thus, " the proposed cubic is depressed to a quadratic " that has one of its roots equal to one of the roots of " that cubic."

If it is the biquadratic that is proposed, viz.  $x^4 - px^3 + qx^2 - rx + s = 0$ , and two of its roots be equal; then supposing  $x = y$ , two of the values of  $y$  must vanish, and the equation of § 2. will be reduced to this form.

$$\left. \begin{array}{l} y^4 + 4ey^3 + 6e^2y^2 \\ - 4py^3 - 3pe^2y^2 \\ + 4y^2y \end{array} \right\} ** = 0. \text{ So that}$$

$$4e^3 - 3pe^2 + 2qe - r = 0; \text{ or, because } x = e,$$

$$4x^3 - 3px^2 + 2qx - r = 0.$$

In general, when two values of  $x$  are equal to each other, and to  $e$ , the two last terms of the transformed equation vanish: and consequently, " if you multiply " the terms of the proposed equation by the indices of "  $x$  in each term, the quantity that will arise will be  $= 0$ , " and will give an equation of a lower dimension than " the proposed, that shall have one of its roots equal " to one of the roots of the proposed equation."

That the last two terms of the equation vanish when the values of  $x$  are supposed equal to each other, and to  $e$ , will also appear by considering, that since two values of  $y$  then become equal to nothing, the product of the values of  $y$  must vanish, which is equal to the last term of the equation; and because two of the four values of  $y$  are equal to nothing, it follows also that one of any three that can be taken out of these four must be  $= 0$ ; and therefore, the products made by multiplying any three must vanish; and consequently the coefficient of the last term but one, which is equal to the sum of these products, must vanish.

§ 5. After the same manner, if there are three equal roots in the biquadratic  $x^4 - px^3 + qx^2 - rx + s = 0$ , and if  $e$  be equal to one of them, three values of  $y$  ( $= x - e$ ) will vanish, and consequently  $y^3$  will enter all the terms of the transformed equation; which will have this form,

$$\left. \begin{array}{l} y^4 + 4ey^3 \\ - 4py^3 \end{array} \right\} *** = 0. \text{ So that here}$$

$$6e^2 - 3pe + q = 0; \text{ or, since } x = e, \text{ therefore,}$$

$$6x^2 - 3px + q = 0; \text{ and one of the roots of this quadratic will be equal to one of the roots of the proposed biquadratic.}$$

In this case, two of the roots of the cubic equation  $4x^3 - 3px^2 + 2qx - r = 0$  are roots of the proposed biquadratic, because the quantity  $6x^2 - 3px + q$  is deduced from  $4x^3 - 3px^2 + 2qx - r$ , by multiplying the terms by the indexes of  $x$  in each term.

In general, " whatever is the number of equal roots " in the proposed equation, they will all remain but one " in the equation that is deduced from it, by multiplying " all the terms by the indexes of  $x$  in them; and they " will all remain but two in the equation deduced in the " same manner from that;" and so of the rest.

§ 6. What we observed of the coefficients of equations transformed by supposing  $y = x - e$ , leads to this easy demonstration of this rule; and will be applied in the next chapter to demonstrate the rules for finding the limits of equations,

It is obvious, however, that though we make use of equations whose signs change alternately, the same reasoning extends to all other equations.

It is a consequence also of what has been demonstrated, that " if two roots of any equation, as,

"  $x^2 - px^2 + qx - r = 0$ , are equal, then " multiplying the terms by any arithmetical series, as, "  $a + 3b, a + 2b, a + b, a$ , the product will be  $= 0$ ."

For, since

$$ax^3 - apx^2 + aqx - ar = 0; \text{ and}$$

$$3x^2 - 2px + qx - r = 0; \text{ it follows that}$$

$$ax^3 + 3bx^2 - apx^2 - 2bpx^2 + aqx + bqx - ar = 0.$$

Which is the product that arises by multiplying the terms of the proposed equation by the terms of the series,  $a + 3b, a + 2b, a + b, a$ ; which may represent any arithmetical progression.

### CHAP. XVIII. Of the LIMITS of Equations.

WE now proceed to shew how to discover the limits of the roots of equations, by which their solution is much facilitated,

Let any equation, as  $x^3 - px^2 + qx - r = 0$  be proposed; and transform it, as above, into the equation

$$\left. \begin{array}{l} y^3 + 3ey^2 + 3e^2y + e^3 \\ - 4py^2 - 2pe^2y - pe^3 \\ + 4y + qe \\ - r \end{array} \right\} = 0.$$

Where the values of  $y$  are less than the respective values of  $x$  by the difference  $e$ . If you suppose  $e$  to be taken such as to make all the coefficients of the equation of  $y$  positive, viz.  $e^3 - pe^2 + qe - r, 3e^2 - 2pe + q, 3e - p$ ; then there being no variation of the signs in the equation, all the values of  $y$  must be negative; and consequently, the quantity  $e$ , by which the values of  $x$  are diminished, must be greater than the greatest positive value of  $x$ ; and consequently must be the limit of the roots of the equation  $x^3 - px^2 + qx - r = 0$ .

It is sufficient therefore, in order to find the limit, to inquire what quantity substituted for  $x$  in each of these " expressions  $x^3 - px^2 + qx - r, 3x^2 - 2px + q, 3x - p$  " will give them all positive;" for that quantity will be the limit required.

How these expressions are formed from one another, was explained in the beginning of the last chapter.

EXAMP. If the equation  $x^5 - 2x^4 - 10x^3 + 30x^2 + 63x + 120 = 0$  is proposed; and it is required to determine the limit that is greater than any of the roots; you are to inquire what integer number substituted for  $x$  in the proposed equation, and following equations deduced from it by § 3. chap. 17. will give, in each, a positive quantity,

$$\begin{array}{l} 5x^4 - 8x^3 - 30x^2 + 60x + 63 \\ 5x^3 - 6x^2 - 15x + 15 \\ 5x^2 - 4x - 5 \\ 5x - 2. \end{array}$$

The least integer number which gives each of these positive, is 2; which therefore is the limit of the roots of



of the proposed equation; or a number that exceeds the greatest positive root.

If the limit of the *negative* roots is required, you may (by chap. 16.) change the negative into positive roots, and then proceed as before to find their limits. Thus, in the example, you will find, that  $-3$  is the limit of the negative roots. So that the five roots of the proposed equation are betwixt  $-3$  and  $+2$ .

Having found the limit that surpasses the greatest positive root, call it  $m$ . And if you assume  $y = m - x$ , and for  $x$  substitute  $m - y$ , the equation that will arise will have all its roots positive; because  $m$  is supposed to surpass all the values of  $x$ , and consequently  $m - x$  ( $\Rightarrow$ ) must always be affirmative. And, by this means, *any equation may be changed into one that shall have all its roots affirmative.*

Or, if  $-n$  represent the limit of the negative roots, then by assuming  $y = x + n$ , the proposed equation shall be transformed into one that shall have all its roots affirmative; for  $+n$  being greater than any negative value of  $x$ , it follows, that  $y = x + n$  must be always positive.

*The greatest negative coefficient of any equation increased by unit, always exceeds the greatest root of the equation.*

To demonstrate this, let the cubic  $x^3 - px^2 - qx - r = 0$  be proposed; where all the terms are negative except the first. Assuming  $y = x - e$ , it will be transformed into the following equation;

$$(A) \left. \begin{array}{l} y^3 + 3ey^2 + 3e^2y + e^3 \\ -py^2 - 2pey - pe^2 \\ -qy - qe \\ -r \end{array} \right\} = 0.$$

1°. Let us suppose that the coefficients  $p, q, r$ , are equal to each other; and if you also suppose  $e = p + 1$ , then the last equation becomes

$$(B) \left. \begin{array}{l} y^3 + 2py^2 + p^2y + 1 \\ + 3y^2 + 3py \\ + 3y \end{array} \right\} = 0;$$

where all the terms being positive, it follows that the values of  $y$  are all negative, and that consequently  $e$ , or  $p + 1$ , is greater than the greatest value of  $x$  in the proposed equation.

2°. If  $q$  and  $r$  be not  $= p$ , but less than it, and for  $e$  you still substitute  $p + 1$  (since the negative part  $(-qy - qe)$

becomes less, the positive remaining undiminished,) *a fortiori*, all the coefficients of the equation (A) become positive. And the same is obvious if  $q$  and  $r$  have positive signs, and not negative signs, as we supposed. It appears therefore, "that if, in any cubic equation,  $p$  be the greatest negative coefficient; then  $p + 1$  must surpass the greatest value of  $x$ ."

3°. By the same reasoning it appears, that if  $q$  be the greatest negative coefficient of the equation, and  $e = p + 1$ , then there will be no variation of the signs in the equation of  $y$ : for it appears from the last article, that if all the three ( $p, q, r$ .) were equal to one another, and  $e$  equal to any one of them increased by unit, as to  $q + 1$ , then all the terms of the equation (A) would be

positive. Now if  $e$  be supposed still equal to  $q + 1$ , and  $p$  and  $r$  to be less than  $q$ , then, *a fortiori*, all these terms will be positive, the negative part, which involves  $p$  and  $r$  being diminished, while the positive part and the negative involving  $q$  remain as before.

4°. After the same manner it is demonstrated, that if  $r$  is the greatest negative coefficient in the equation, and  $e$  is supposed  $= r + 1$ , then all the terms of the equation (A) of  $y$  will be positive; and consequently  $r + 1$  will be greater than any of the values of  $x$ .

What we have said of the cubic equation  $x^3 - px^2 + qx - r = 0$ , is easily applicable to others.

In general, we conclude, that "the greatest negative coefficient in any equation increased by unit, is always a limit that exceeds all the roots of that equation."

But it is to be observed at the same time, that the greatest negative coefficient increased by unit, is very seldom the *nearest* limit: that is best discovered by the rule in the beginning of this chapter.

Having shewn how to change any proposed equation into one that shall have all its roots affirmative; we shall only treat of such as have all their roots positive, in what remains relating to the limits of equations.

Any such equation may be represented by  $x - a \times x - b \times x - c \times x - d$ , &c.  $= 0$ , whose roots are  $a, b, c, d$ , &c.

And of all such equations two limits are easily discovered from what precedes, *viz.* 0, which is less than the least, and  $e$ , found as directed in the beginning of this chapter, which surpasses the greatest root of the equation.

But, besides these, we shall now shew how to find *other limits betwixt the roots themselves.* And, for this purpose, will suppose  $a$  to be the least root,  $b$  the second root,  $c$  the third, and so on; it being arbitrary.

If you substitute 0 in place of the unknown quantity, putting  $x = 0$ , the quantity that will arise from that supposition is the last term of the equation, all the others that involve  $x$  vanishing.

If you substitute for  $x$  a quantity less than the least root  $a$ , the quantity resulting will have the same sign as the last term; that is, will be positive or negative according as the equation is of an even or odd number of dimensions. For all the factors  $x - a, x - b, x - c$ , &c. will be negative, and their product will be *positive* or *negative* according as their number is *even* or *odd*.

If you substitute for  $x$  a quantity greater than the least root  $a$ , but less than all the other roots, then the sign of the quantity resulting will be contrary to what it was before; because one factor  $(x - a)$  becomes now positive, all the others remaining negative as before.

If you substitute for  $x$  a quantity greater than the two least roots, but less than all the rest, both the factors  $x - a, x - b$ , become positive, and the rest remain as they were. So that the whole product will have the same sign as the last term of the equation. Thus successively placing instead of  $x$  quantities that are limits betwixt the roots of the equation, the quantities that result will have alternately the signs  $+$  and  $-$ . And, *conversely*, "if you find quantities which, substituted in place of  $x$  in the proposed equation, do give alternately positive and negative results, those quantities are the limits of that equation."

It is useful to observe, that, in general, “ when, by “ substituting any two numbers for  $x$  in any equation, “ the results have contrary signs, one or more of the “ roots of the equation must be betwixt those numbers.” Thus, in the equation,  $x^3 - 2x^2 - 5 = 0$ , if you substitute 2 and 3 for  $x$ , the results are  $-5$ ,  $+4$ ; whence it follows, that the roots are betwixt 2 and 3: for when these results have different signs, one or other of the factors which produce the equations must have changed its sign; suppose it is  $x = e$ , then it is plain that  $e$  must be betwixt the numbers supposed equal to  $x$ .

Let the cubic equation  $x^3 - px^2 + qx - r = 0$  be proposed, and let it be transformed, by assuming  $y = x - e$ , into the equation

$$\left. \begin{aligned} y^3 + 3ey^2 + 3e^2y + e^3 \\ - py^2 - 2pey - pe^2 \\ + qy + qe \\ - r \end{aligned} \right\} = 0.$$

Let us suppose  $e$  equal successively to the three values of  $x$ , beginning with the least value; and because the last term  $e^3 - pe^2 + qe - r$  will vanish in all these suppositions, the equation will have this form,

$$\left. \begin{aligned} y^3 + 3ey + 3e^2 \\ - py - 2pe \\ + q \end{aligned} \right\} = 0;$$

where the last term  $3e^2 - 2pe + q$  is, from the nature of equations, produced of the remaining values of  $y$ , or of the excesses of two other values of  $x$  above what is supposed equal to  $e$ ; since always  $y = x - e$ . Now,

1° If  $e$  be equal to the least value of  $x$ , then those two excesses being both positive, they will give a positive product, and consequently  $3e^2 - 2pe + q$  will be, in this case, positive.

2° If  $e$  be equal to the second value of  $x$ , then, of those two excesses, one being negative and one positive, their product  $3e^2 - 2pe + q$ , will be negative.

3° If  $e$  be equal to the third and greatest value of  $x$ , then the two excesses being both negative, their product  $3e^2 - 2pe + q$  is positive. Whence,

If in the equation  $3e^2 - 2pe + q = 0$ , you substitute successively in the place of  $e$ , the three roots of the equation  $e^3 - pe^2 + qe - r = 0$ , the quantities resulting will successively have the signs  $+$ ,  $-$ ,  $+$ ; and consequently the three roots of the cubic equation are the limits of the roots of the equation  $3e^2 - 2pe + q = 0$ . That is, the least of the roots of the cubic is less than the least of the roots of the other; the second root of the cubic is a limit between the two roots of the other; and the greatest root of the cubic is the limit that exceeds both the roots of the other.

We have demonstrated, that the roots of the cubic equation  $e^3 - pe^2 + qe - r = 0$  are limits of the quadratic  $3e^2 - 2pe + q$ ; whence it follows (*conversely*) that the roots of the quadratic  $3e^2 - 2pe + q = 0$  are the limits between the first and second, and between the second and third roots of the cubic  $e^3 - pe^2 + qe - r = 0$ . So that if you find the limit that exceeds the greatest root of the cubic, by the beginning of this chapter you will have (with  $o$ ,

which is the limit less than any of the roots) four limits of the three roots of the proposed cubic.

It was demonstrated in chap 17. §3. how the quadratic  $3e^2 - 2pe + q$  is deduced from the proposed cubic  $e^3 - pe^2 + qe - r = 0$ , viz. by multiplying each term by the index of  $e$  in it, and then dividing the whole by  $e$ ; and what we have demonstrated of cubic equations is easily extended to all others; so that we conclude “ that the “ last term but one of the transformed equation is the “ equation for determining the limits of the proposed “ equation.” Or, that the equation arising by multiplying each term by the index of the unknown quantity in it, is the equation whose roots give the limits of the proposed equation; if you add to them the two mentioned in p. 109. col. 2. par. 4.

For the same reason, it is plain that the root of the simple equation  $3e - p = 0$ , (*i. e.*  $\frac{1}{3}p$ ) is the limit between the two roots of the quadratic  $3e^2 - 2pe + q = 0$ . And, as  $4e^3 - 3pe^2 + 2qe - r = 0$  gives three limits of the equation  $e^3 - pe^2 + qe - r = 0$ , so the quadratic  $6e^2 - 3pe + q = 0$  gives two limits that are betwixt the roots of the cubic  $4e^3 - 3pe^2 + 2qe - r = 0$ ; and  $4e - p = 0$  gives one limit that is betwixt the two roots of the quadratic  $6e^2 - 3pe + q = 0$ . So that we have a complete series of these equations arising from a simple equation to the proposed, each of which determines the limits of the following equation.

If two roots in the proposed equation are equal, then “ the limit that ought to be betwixt them must, “ in this case, become equal to one of the equal roots “ themselves.” Which perfectly agrees with what was demonstrated in the last chapter, concerning the rule for finding the equal roots of equations.

And, the same equation that gives the limits, giving also one of the equal roots, when two or more are equal, it appears, that “ if you substitute a limit in place of “ the unknown quantity in an equation,” and, instead of a positive or negative result, it be found  $= 0$ , then you may conclude, that “ not only the limit itself is a root “ of the equation, but that there are two roots in that “ equation equal to it and to one another.”

It having been demonstrated, that the roots of the equation  $x^3 - px^2 + qx - r = 0$  are the limits of the roots of the equation  $3x^2 - 2px + q = 0$ , the three roots of the cubic equation, which suppose to be  $a, b, c$ , substituted for  $x$  in the quadratic  $3x^2 - 2px + q$ , must give the results positive and negative alternately. Suppose these three results to be  $+N, -M, +L$ ; that is,  $3a^2 - 2pa + q = N, 3b^2 - 2pb + q = -M, 3c^2 - 2pc + q = L$ ; and since  $a^3 - pa^2 + qa - r = 0$ , and  $3a^2 - 2pa + q = N \times a$ , subtracting the former multiplied into 3 from the latter, the remainder is  $pa^2 - 2qa + 3r = N \times a$ . In the same manner  $pb^2 - 2qb + 3r = M \times b$ , and  $pc^2 - 2qc + 3r = L \times c$ . Therefore  $px^2 - 2qx + 3r$  is such a quantity, that if, for  $x$ , you substitute in it successively  $a, b, c$ , the results will be  $+N \times a, -M \times b, +L \times c$ . Whence  $a, b, c$ , are limits of the equation  $px^2 - 2qx + 3r = 0$ , by p. 109. col. 2. par. 8. and, *conversely*, the roots of the equation  $px^2 - 2qx + 3r = 0$  are limits between the first and second, and between the second and third roots of the cubic  $x^3 - px^2 + qx - r = 0$ . Now the equation  $px^2 - 2qx + 3r = 0$  a-

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finds from the proposed cubic by multiplying the terms of this latter by the arithmetical progression 0, -1, -2, -3. And, in the same manner, it may be shewn that the roots of the equation  $px^3 - 2qx^2 + 3rx - 4 = 0$  are limits of the equation  $x^3 - px^2 + qx - r = 0$ .

Or, multiply the terms of the equation

$$x^3 - px^2 + qx - r = 0$$

by  $a+3b, a+2b, a+b, a$

$$\frac{ax^3 - apx^2 + aqx - ar (=0)}{+3bx^3 - 2bp^2x^2 + bqx (=3x^3 - 2px^2 + qx \times bx.)}$$

Any arithmetical series where  $a$  is the least term, and  $b$  the common difference, and the products (if you substitute for  $x$ , successively,  $a, b, c$ , the three roots of the proposed cubic) shall be  $+N \times bx, -M \times bx + L \times bx$ . For the first part of the product  $a \times x^3 - px^2 + qx - r = 0$ ; and  $a, b, c$ , being limits in the equation  $3x^3 - 2px^2 + qx = 0$ , their substitution must give results  $N, M, L$ , alternately positive and negative.

In general, the roots of the equation  $x^n - px^{n-1} + qx^{n-2} - rx^{n-3} + \dots$  are limits of the roots of the equation  $nx^{n-1} - (n-1)px^{n-2} + (n-2)qx^{n-3} - (n-3)rx^{n-4} + \dots$ ; or of any equation that is deduced from it by multiplying its terms by any arithmetical progression,  $a, 2b, 3b, 4b, \dots$ . And, conversely, the roots of this new equation will be limits of the proposed equation

$$x^n - px^{n-1} + qx^{n-2} - \dots, \&c. = 0.$$

"If any roots of the equation of the limits are impossible, then must there be some roots of the proposed equation impossible." For as (in p. 110. col. 1. par. 2.) the quantity  $3x^2 - 2px + q$  was demonstrated to be equal to the product of the excesses of two values of  $x$  above the third supposed equal to  $e$ ; if any impossible expression be found in those excesses, then there will of consequence be found impossible expressions in these two values of  $x$ .

And "from this observation rules may be deduced for discovering when there are impossible roots in equations." Of which we shall treat afterwards.

Besides the method already explained, there are others by which limits may be determined which the root of an equation cannot exceed.

Since the squares of all real quantities are affirmative, it follows, that "the sum of the squares of the roots of any equation must be greater than the square of the greatest root." And the square root of that sum will therefore be a limit that must exceed the greatest root of the equation.

If the equation proposed is  $x^n - px^{n-1} + qx^{n-2} - rx^{n-3} + \dots = 0$ , then the sum of the squares of the roots (p. 103. col. 1. par. 1) will be  $p^2 - 2q$ . So that  $\sqrt{p^2 - 2q}$  will exceed the greatest root of that equation.

Or if you find, by p. 103. col. 1. par. 4. the sum of the 4th powers of the roots of the equation, and extract the biquadratic root of that sum, it will also exceed the greatest root of the equation.

If you had a mean proportional between the sum of the squares of any two roots,  $a, b$ , and the sum of their

biquadrates ( $a^4 + b^4$ ), this mean proportional will be

$\sqrt{a^6 + a^2b^4 + a^4b^2 + b^6}$ . And the sum of the cubes is  $a^3 + b^3$ . Now, since  $a^2 - 2ab + b^2$  is the square of  $a - b$ , it must be always positive; and if you multiply it by  $a^2b^2$ , the product  $a^4b^2 - 2a^3b^3 + a^2b^4$  will also be positive; and consequently  $a^4b^2 + a^2b^4$  will be always greater than  $2a^3b^3$ . Add  $a^6 + b^6$  and we have  $a^6 + a^4b^2 + a^2b^4 + b^6$  greater than  $a^6 + 2a^3b^3 + b^6$ ; and extracting the root

$\sqrt{a^6 + a^4b^2 + a^2b^4 + b^6}$  greater than  $a^3 + b^3$ . And the same may be demonstrated of any number of roots whatever.

Now, if you add the sum of all the cubes taken affirmatively to their sum with their proper signs, they will give double the sum of the cubes of the affirmative roots. And if you subtract the second sum from the first, there will remain double the sum of the cubes of the negative roots. Whence it follows, that "half the sum of the mean proportional betwixt the sum of the squares and the sum of the biquadrates, and of the sum of the cubes of the roots with their proper signs, exceeds the sum of the cubes of the affirmative roots;" and "half their difference exceeds the sum of the cubes of the negative roots." And, by extracting the cube root of that sum and difference, you will obtain limits that shall exceed the sums of the affirmative and of the negative roots. And since it is easy, from what has been already explained, to diminish the roots of an equation so that they all may become negative but one, it appears how, by this means, you may approximate very near to that root. But this does not serve when there are impossible roots.

Several other rules like these might be given for limiting the roots of equations. We shall give one not mentioned by other authors.

In a cubic  $x^3 - px^2 + qx - r = 0$ , find  $q^2 - 2pr$ , and call it  $e^4$ ; then shall the greatest root of the equation always

be greater than  $\sqrt[4]{\frac{e^4}{3}}$ , or  $\sqrt[4]{\frac{e^4}{3}}$ . And,

In any equation  $x^n - px^{n-1} + qx^{n-2} - rx^{n-3} + \dots = 0$ , find  $\frac{q^2 - 2pr + 2r}{n}$ , and extracting the root of the 4th

power out of that quantity, it shall always be less than the greatest root of the equation.

### CHAP. XIX. Of the Resolution of Equations, all whose Roots are commensurate.

It was demonstrated in chap. 15. that the last term of any equation is the product of its roots: from which it follows, that the roots of an equation, when commensurable quantities, will be found among the divisors of the last term. And hence we have, for the resolution of equations, this

**RULE.** Bring all the terms to one side of the equation, find all the divisors of the last term, and substitute them successively for the unknown quantity in the equation. So shall that divisor which, substituted in this manner,

manner, gives the result = 0, be the root of the proposed equation.

For example, suppose this equation is to be resolved,

$$x^3 - 3ax^2 + 2a^2x - 2a^2b = 0$$

where the last term is  $2a^2b$ , whose simple literal divisors are  $a, b, 2a, 2b$ , each of which may be taken either positively or negatively: but as here we find there are variations of signs in the equation, we need only take them positively. Suppose  $x=a$  the first of the divisors, and substituting  $a$  for  $x$ , the equation becomes

$$a^3 - 3a^3 + 2a^3 - 2a^2b = 0 \text{ or } 3a^3 - 3a^3 + 2a^2b - 2a^2b = 0$$

So that, the whole vanishing, it follows, that  $a$  is one of the roots of the equation.

After the same manner, if you substitute  $b$  in place of  $a$ , the equation is

$$b^3 - 3ab^2 + 2a^2b - 2a^2b = 0$$

which vanishing, shews  $b$  to be another root of the equation

Again, if you substitute  $2a$  for  $x$ , you will find all the terms destroy one another so as to make the sum = 0. For it will then be

$$8a^3 - 12a^3 + 4a^3 - 2a^2b = 0$$

Whence we find, that  $2a$  is the third root of the equation. Which, after the first two ( $+a, +b$ ), had been found, might have been collected from this, that the last term being the product of the three roots,  $+a, +b$ , being known, the third must necessarily be equal to the last term divided by the product  $ab$ , that is,  $\frac{2a^2b}{ab} = 2a$ .

Let the roots of the cubic equation

$$x^3 - 2x^2 - 33x + 90 = 0$$

And first the divisors of 90 are found to be 1, 2, 3, 5, 6, 9, 10, 15, 18, 30, 45, 90. If you substitute 1 for  $x$ , you will find  $x^3 - 2x^2 - 33x + 90 = 56$ ; so that 1 is not a root of the equation. If you substitute 2 for  $x$ , the result will be 24: but, putting  $x=3$ , you have

$x^3 - 2x^2 - 33x + 90 = 27 - 18 - 99 + 90 = 117 - 117 = 0$ . So that three is one of the roots of the proposed equation. The other affirmative root is  $+5$ ; and after you find it, as it is manifest from the equation, that the other root is negative, you are not to try any more divisors taken positively, but to substitute them, negatively taken, for  $x$ : and thus you find, that  $-6$  is the third root. For putting  $x=-6$ , you have

$$x^3 - 2x^2 - 33x + 90 = -216 - 72 + 198 + 90 = 0$$

This last root might have been found by dividing the last term 90, having its sign changed by 15, the product of the two roots already found.

When one of the roots of an equation is found, in order to find the rest with less trouble, divide the proposed equation by the simple equation which you are to de-

duce from the root already found, and the quotient shall give an equation of a degree lower than the proposed; whose roots will give the remaining roots required.

As for example, the root  $+3$ , first found, gave  $x=3$ , or  $x-3=0$ , whence dividing thus,

$$\begin{array}{r} x-3 \overline{) x^3 - 2x^2 - 33x + 90} \\ \underline{x^3 - 3x^2} \phantom{+ 90} \\ \phantom{x^3} + x^2 - 33x + 90 \\ \phantom{x^3} \underline{x^2 - 3x} \phantom{+ 90} \\ \phantom{x^3} \phantom{x^2} - 30x + 90 \\ \phantom{x^3} \phantom{x^2} \underline{-30x + 90} \\ \phantom{x^3} \phantom{x^2} \phantom{-30x} 0 \end{array}$$

The quotient shall give a quadratic equation  $x^2 + x - 30 = 0$ , which must be the product of the other two simple equations from which the cubic is generated, and whose roots therefore must be two of the roots of that cubic.

Now the roots of that quadratic equation are easily found, by chap. 12. to be  $+5$  and  $-6$ . For,

$$\begin{array}{l} x^2 + x = 30 \\ \text{add } \frac{1}{4} \dots x^2 + x + \frac{1}{4} = 30 + \frac{1}{4} = \frac{121}{4} \\ \sqrt{\dots} x + \frac{1}{2} = \pm \sqrt{\frac{121}{4}} = \pm \frac{11}{2} \\ \text{and } \dots x = \pm \frac{11}{2} - \frac{1}{2} = +5 \text{ or } -6. \end{array}$$

After the same manner, if the biquadratic  $x^4 - 2x^3 - 25x^2 + 26x + 120 = 0$  is to be resolved; by substituting the divisors of 120 for  $x$ , you will find, that  $+3$ , one of those divisors, is one of the roots; the substitution of 3 for  $x$  giving  $81 - 54 - 225 + 78 + 120 = 279 - 279 = 0$ . And therefore, dividing the proposed equation by  $x-3$ , you must inquire for the roots of the cubic  $x^3 + x^2 - 22x - 40 = 0$ , and finding that  $+5$ , one of the divisors of 40, is one of the roots, you divide that cubic by  $x-5$ ; and the quotient gives the quadratic  $x^2 + 6x + 8 = 0$ , whose two roots are  $-2, -4$ . So that the four roots of the biquadratic are  $+3, +5, -2, -4$ .

This rule supposes that you can find all the divisors of the last term; which you may always do thus.

“ If it is a simple quantity, divide it by its least divisor for that exceeds unit, and the quotient again by its least divisor, proceeding thus till you have a quotient that is not divisible by any number greater than unit. This quotient, with these divisors, are the first or simple divisors of the quantity. And the products of the multiplication of any 2, 3, 4, &c. of them are the compound divisors.”

As to find the divisors of 60; first I divide by 2, and the quotient 30 again by 2, then the the next quotient 15 by 3, and the quotient of this division 5 is not farther divisible by any integer above units; so that the simple divisors are,

$$2, 2, 3, 5;$$

The products of two, 4, 6, 10, 15.

The products of three, 12, 20, 30, 60.

The product of all four, 60.

The divisors of 90 are found after the same manner.

Simple

Simple divisors, 2, 3, 3, 5.  
 The products of two, . . . 6, 9, 10, 15.  
 The products of three, . . . 18, 30, 45.  
 The product of all four, . . . . . 90.

The divisors of  $21abb$ .  
 The simple divisors, 3, 7,  $a$ ,  $b$ ,  $b$ .  
 The products of two,  $21$ ,  $3a$ ,  $3b$ ,  $7a$ ,  $7b$ ,  $ab$ ,  $bb$ .  
 The products of three,  $21a$ ,  $21b$ ,  $3ab$ ,  $3bb$ ,  $7ab$ ,  
 $7bb$ ,  $abb$ .  
 The products of four,  $21ab$ ,  $21bb$ ,  $3abb$ ,  $7abb$ .  
 The products of the five, . . . . .  $21abb$ .

But as the last term may have very many divisors, and the labour may be very great to substitute them all for the unknown quantity, we shall now shew how it may be abridged, by limiting to a small number the divisors you are to try. And, first, it is plain, from p. 109. col. 1. par. 4. that "any divisor that exceeds the greatest negative coefficient by unity is to be neglected." Thus, in resolving the equation  $x^4 - 2x^3 - 25x^2 + 26x + 120 = 0$ , as 25 is the greatest negative coefficient, we conclude, that the divisors of 120 that exceed 26 may be neglected.

But the labour may be still abridged, if we make use of the rule in the beginning of ch. 18.; that is, if we find the number which substituted in these following expressions,

$$\begin{aligned} x^4 - 2x^3 - 25x^2 + 26x + 120, \\ 2x^3 - 3x^2 - 25x + 13, \\ 6x^2 - 6x - 25, \\ 2x - 1, \end{aligned}$$

will give in them all a positive result: for that number will be greater than the greatest root, and all the divisors of 120 that exceed it may be neglected.

That this investigation may be easier, we ought to begin always with that expression where the negative roots seem to prevail most; as here in the quadratic expression  $6x^2 - 6x - 25$ ; where finding that 6 substituted for  $x$  gives that expression positive, and gives all the other expressions at the same time positive, I conclude, that 6 is greater than any of the roots, and that all the divisors of 120 that exceed 6 may be neglected.

If the equation  $x^3 + 11x^2 + 10x - 72 = 0$  is proposed, the rule of p. 109. col. 1. par. 4. does not help to abridge the operation; the last term itself being the greatest negative term. But, by chap. 18. we inquire what number substituted for  $x$  will give all these expressions positive.

$$\begin{aligned} x^3 + 11x^2 + 10x - 72 \\ 3x^2 + 22x + 10 \\ 3x + 11. \end{aligned}$$

Suppos.	Result.	Divisors. Arith. Prog. decr.
$x = 1$	. . . . . $x^3 - x^2 - 10x + 6$	$-4   1, 2, 4$   4
$x = 0$		$+6   1, 2, 3, 6$   3 gives $x = -3$
$x = -1$		$+14   1, 2, 7, 14$   2

Where the suppositions of  $x=1$ ,  $x=0$ ,  $x=-1$ , give the quantity  $x^3 - x^2 - 10x + 6$  equal to  $-4$ ,  $6$ ,  $14$ ; among whose divisors we find only one arithmetical progression  
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Where the labour is very short, since we need only attend to the first expression; and we see immediately that 4 substituted for  $x$  gives a positive result, whence all the divisors of 72 that exceed 4 are to be rejected; and thus by a few trials, we find, that  $+2$  is the positive root of the equation. Then dividing the equation by  $x-2$ , and resolving the quadratic equation that is the quotient of the division, you find the other two roots to be  $-9$ , and  $-4$ .

But there is another method that reduces the divisors of the last term, that can be useful, till to more narrow limits.

Suppose the cubic equation  $x^3 - px^2 + qx - r = 0$  is proposed to be resolved. Transform it to an equation whose roots shall be less than the values of  $x$  by unity, assuming  $y = x - 1$ . And the last term of the transformed equation will be  $1 - p + q - r$ ; which is found by substituting unity, the difference of  $x$  and  $y$ , for  $x$ , in the proposed equation; as will easily appear from p. 106. col. 1. par. 4. where, when  $y = x - 1$ , the last term of the transformed equation was  $1 - p + q - r$ .

Transform again the equation  $x^3 - px^2 + qx - r = 0$ , by assuming  $y = x + 1$ , into an equation whose roots shall exceed the values of  $x$  by unity, and the last term of the transformed equation will be  $-1 - p - q - r$ , the same that arises by substituting  $-1$ , the difference betwixt  $x$  and  $y$ , for  $x$ , in the proposed equation.

Now the values of  $x$  are some of the divisors of  $r$ , which is the term left when you suppose  $x=0$ ; and the values of the  $y$ 's are some of the divisors of  $+1 - p + q - r$ , and of  $-1 - p - q - r$ , respectively. And these values are in arithmetical progression increasing by the common difference unity; because  $x-1$ ,  $x$ ,  $x+1$ , are in that progression. And it is obvious the same reasoning may be extended to any equation of whatever degree. So that this gives a general method for the resolution of equations whose roots are commensurable.

**RULE.** Substitute, in place of the unknown quantity, successively the terms of the progression, 1, 0,  $-1$ , &c. and find all the divisors of the sums that result; then take out all the arithmetical progressions you can find among these divisors, whose common difference is unity; and the values of  $x$  will be among the divisors arising from the substitutions of  $x=0$  that belong to these progressions. The values of  $x$  will be affirmative when the arithmetical progression increases, but negative when it decreases.

**EXAMP.** Let it be required to find one of the roots of the equation  $x^3 - x^2 - 10x + 6 = 0$ . The operation is thus;

succeeding one of its roots must be  $-3$ . Then dividing the equation by  $x+3$ , we find the roots of the (quadratic) quotient  $x^2-4x+2=0$  are  $2 \pm \sqrt{2}$ .

If it is required to find the roots of the equation  $x^3 - 3x^2 - 46x - 72 = 0$ , the operation will be thus;

Suppos.	Results	Divisors.	Progressions.
$x = 1$	120	1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 20, 24, 30, 40, 60, 120.	8 3 4 5
$x = 0$	72	1, 2, 3, 4, 6, 8, 9, 12, 18, 24, 36, 72.	9 2 3 4
$x = -1$	30	1, 2, 3, 5, 6, 10, 15, 30.	10 1 2 3

Of these four arithmetical progressions having their common difference equal to unit, the first gives  $x=0$ , the others give  $x=-2$ ,  $x=-3$ ,  $x=-4$ ; all which succeed except  $x=-3$ : so that the three values of  $x$  are  $+3, -2, -4$ .

CHAP. XX. *Of the Resolution of Equations by finding the Equations of a lower Degree that are their Divisors.*

To find the roots of an equation is the same thing as to find the simple equations, by the multiplication of which into one another it is produced, or, to find the simple equations that divide it without a remainder.

If such simple equations cannot be found, yet if we can find the quadratic equations from which the proposed equation is produced, we may discover its roots afterwards by the resolution of these quadratic equations. Or, if neither these simple equations, nor these quadratic equations can be found, yet, by finding a cubic or biquadratic that is a divisor of the proposed equation, we may depress it lower, and make the solution more easy.

Now, in order to find the rules by which these divisors may be discovered, we shall suppose, that

$$\left. \begin{matrix} mx-n \\ mx^2-nx+r \\ mx^3-nx^2+rx-s \end{matrix} \right\} \text{are the } \left\{ \begin{matrix} \text{simple} \\ \text{quadratic} \\ \text{cubic} \end{matrix} \right.$$

divisors of the proposed equation; and if  $E$  represent the quotient arising by dividing the proposed equation by that divisor, then

$$\begin{matrix} E \times \overline{mx-n}, \\ E \times \overline{mx^2-nx+r}, \end{matrix}$$

Or,  $E \times \overline{mx^3-nx^2+rx-s}$ , will represent the proposed equation itself. Where it is plain, that "since  $m$  is the coefficient of the highest term of the divisors, it must be a divisor of the coefficient of the highest term of the proposed equation."

Next we are to observe, that, supposing the equation has a simple divisor  $mx-n$ , if we substitute in the equation  $E \times \overline{mx-n}$ , in place of  $x$ , any quantity, as  $a$ , then the quantity that will result from this substitution will necessarily have  $ma-n$  for one of its divisors: since, in this substitution,  $mx-n$  becomes  $ma-n$ .

If we substitute successively for  $x$ , any arithmetical progression,  $a, a-e, a-2e$ , &c. the quantities that will result from these substitutions will have among their divisors

$ma-n,$   
 $ma-me-n,$   
 $ma-2me-n,$  which are also in arithmetical progression, having their common difference equal to  $me$ .

If, for example, we substitute for  $x$  the terms of this progression,  $1, 0, -1$ , the quantities that result have among their divisors the arithmetical progression  $m-n, -n, -m-n$ ; or, changing the signs,  $n-m, n, n+m$ . Where the difference of the terms is  $m$ , and the term belonging to the supposition of  $x=0$  is  $n$ .

It is manifest therefore, that when an equation has any simple divisor, if you substitute for  $x$  the progression  $1, 0, -1$ , there will be found amongst the divisors of the sums that result from these substitutions, one arithmetical progression at least, whose common difference will be unit or a divisor  $m$  of the coefficient of the highest term, and which will be the coefficient of  $x$  in the simple divisor required: and whose term, arising from the supposition of  $x=0$ , will be  $n$ , the other member of the simple divisor  $mx-n$ .

From which this rule is deduced for discovering such a simple divisor, when there is any.

**RULE.** Substitute for  $x$  in the proposed equation successively the numbers  $1, 0, -1$ . Find all the divisors of the sums that result from this substitution, and take out all the arithmetical progressions you can find amongst them, whose difference is unit, or some divisor of the coefficient of the highest term of the equation. Then suppose  $n$  equal to that term of any one progression that arises from the supposition of  $x=0$ , and  $m$  the fore said divisor of the coefficient of the highest term of the equation, which  $m$  is also the difference of the terms of this progression; so shall you have  $mx-n$  for the divisor required.

You may find arithmetical progressions giving divisors that will not succeed; but if there is any divisor, it will be found thus by means of these arithmetical progressions.

If the equation proposed has the coefficient of its highest term  $=1$ , then it will be  $m=1$ , and the divisor will be  $x-n$ , and the rule will coincide with that given in the end of the last chapter, which we demonstrated after a different manner; for the divisor being  $x-n$ , the value of  $x$  will be  $+n$ , the term of the progression that is a divisor of the sum that arises from supposing  $x=0$ . Of this case we gave examples in the last chapter; and though it is easy to reduce an equation whose highest term has a coefficient different from unit, to one where that coefficient shall be unit, by p. 106. col. 1. par. 6.; yet, without that reduction, the equation may be resolved by this rule, as in the following

EXAMP.

EXAMP. Suppose  $8x^3 - 26x^2 + 11x + 10 = 0$ , and that it is required to find the values of  $x$ ; the operation is thus;

Suppos.	Results.	Divisors.	Progr.
$x = 1$	$8x^3 - 26x^2 + 11x + 10 =$	$+ 3$	$1, 3.$
$x = 0$		$+ 10$	$1, 2, 5, 10.$
$x = -1$		$- 35$	$1, 5, 7, 35.$

The difference of the terms of the last arithmetical progression is 2, a divisor of 8, the coefficient of the highest term  $x^3$  of the equation, therefore supposing  $m=2, n=5$ , we try the divisor  $2x-5$ ; which succeeding, it follows, that  $2x-5=0$ , or  $x=2\frac{1}{2}$ .

The quotient is the quadratic  $4x^2 - 3x - 2 = 0$ , whose roots are  $\frac{3 + \sqrt{41}}{8}$ , and  $\frac{3 - \sqrt{41}}{8}$ , so that the three

roots of the proposed equation are  $2\frac{1}{2}, \frac{3 + \sqrt{41}}{8},$

$\frac{3 - \sqrt{41}}{8}$ . The other arithmetical progression gives

$x+2$  for a divisor; but it does not succeed.

If the proposed equation has no simple divisor, then we are to inquire if it has not some quadratic divisor (if itself is an equation of more than three dimensions.)

An equation having the divisor  $mx^2 - nx + r$  may be expressed, as in the first article of this chapter, by  $EXmx^2 - nx + r$ ; and if we substitute for  $x$  any known quantity  $a$ , the sum that will result will have  $ma^2 - na + r$  for one of its divisors; and, if we substitute successively for  $x$  the progression  $a, a-e, a-2e, a-3e, \&c.$  the sums that arise from this substitution will have

$$\begin{aligned} & ma^2 - na + r \\ & m \times (a-e)^2 - n \times a - e + r \\ & m \times (a-2e)^2 - n \times a - 2e + r \\ & m \times (a-3e)^2 - n \times a - 3e + r, \\ & \&c. \end{aligned}$$

among their divisors respectively.

These terms are not now, as in the last case, in arithmetical progression; but if you subtract them from the squares of the terms  $a, a-e, a-2e, a-3e, \&c.$  multiplied by  $m$  a divisor of the highest term of the proposed equation, that is from

$$\begin{aligned} & ma^2 \\ & m \times (a-e)^2 \\ & m \times (a-2e)^2 \\ & m \times (a-3e)^2, \&c. \end{aligned}$$

$$\begin{aligned} & na - r \\ & n \times a - e - r \\ & n \times a - 2e - r \end{aligned}$$

$n \times a - 3e - r, \&c.$  shall be in arithmetical progression, having their common difference equal to  $n \times e$ .

If, for example, we suppose the assumed progression  $a, a-e, a-2e, a-3e, \&c.$  to be  $2, 1, 0, -1$ , the divisors will be

$$\begin{aligned} & 4m - 2n + r \\ & m - n + r \\ & + r \\ \hline & m + n + r, \text{ which subtracted from } 4m, \\ & m, 0, m, \text{ leave } 2n - r \end{aligned}$$

$n - r$   
 $- r$   
 $- n - r,$  an arithmetical progression whose difference is  $+n$ ; and whose term, arising from the substitution of 0 for  $x$ , is  $-r$ .

From which it follows, that by this operation, if the proposed equation has a quadratic divisor, you will find an arithmetical progression that will determine to you  $n$  and  $r$ , the coefficient  $m$  being supposed known; since it is unit, or a divisor of the coefficient of the highest term of the equation. Only you are to observe, that if the first term  $mx^2$  of the quadratic divisor is negative, then in order to obtain an arithmetical progression, you are not to subtract, but add the divisors  $-4m - 2n + r, -m - n + r, +r, -m + n + r,$  to the terms  $4m, m, 0, m.$

The general rule therefore, deduced from what we had said, is,

“Substitute in the proposed equation for  $x$  the terms  $2, 1, 0, -1, \&c.$  successively. Find all the divisors of the sums that result, adding and subtracting them from the squares of these numbers  $2, 1, 0, -1, \&c.$  multiplied by a numerical divisor of the highest term of the proposed equation, and take out all the arithmetical progressions that can be found amongst these sums and differences. Let  $r$  be that term in any progression that arises from the substitution of  $x=0$ , and let  $+n$  be the difference arising from subtracting that term from the preceding term in the progression; lastly, let  $m$  be the fore said divisor of the highest term; then shall  $\frac{mx^2 - nx + r}{m}$  be the divisor that ought to be tried.” And one or other of the divisors found in this manner will succeed, if the proposed equation has a quadratic divisor.

CHAP. XXI. *Of the Methods by which you may approximate to the Roots of NUMERICAL Equations by their Limits.*

WHEN any equation is proposed to be resolved, first find the limits of the roots (by chap. 17.) as for example, if the roots of the equation  $x^2 - 16x + 55 = 0$  are required, you find the limits are 0, 8, and 17, by p. 110. col. 2. par. 2.; that is, the least root is between 0 and 8, and the greatest between 8 and 17.

In order to find the first of the roots, I consider, that if I substitute 0 for  $x$  in  $x^2 - 16x + 55$ , the result is positive, viz.  $+55$ , and consequently any number betwixt 0 and 8 that gives a positive result, must be less than the least root, and any number that gives a negative result must be greater. Since 0 and 8 are the limits, I try 4, that is, the mean betwixt them, and supposing  $x=4, x^2 - 16x + 55 = 16 - 64 + 55 = 7$ , from which I conclude that the root is greater than 4. So that now we have the root limited between 4 and 8. Therefore

I next try 6, and substituting it for  $x$  we find  $x^2 - 16x + 55 = 36 - 96 + 55 = -5$ ; which result being negative, I conclude that 6 is greater than the root required, which therefore is limited now between 4 and 6. And substituting 5, the mean between them, in place of  $x$ , I find  $x^2 - 16x + 55 = 25 - 80 + 55 = 0$ ; and consequently 5 is the least root of the equation. After the same manner you will discover 11 to be the greatest root of that equation.

Thus by diminishing the greater, or increasing the lesser limit, you may discover the true root when it is a commensurable quantity. But, by proceeding after this manner, when you have two limits, the one greater than the root, the other lesser, that differ from one another but by unit, then you may conclude the root is *incommensurable*.

We may however, by continuing the operation in fractions, approximate to it. As if the equation proposed is  $x^2 - 6x + 7 = 0$ , if we suppose  $x = 2$ , the result is  $4 - 12 + 7 = -1$ , which being negative, and the supposition  $x = 0$  giving a positive result, it follows that the root is between 0 and 2. Next we suppose  $x = 1$ ; whence  $x^2 - 6x + 7 = 1 - 6 + 7 = +2$ , which being positive, we infer the root is betwixt 1 and 2, and consequently incommensurable. In order to approximate to it, we suppose  $x = 1\frac{1}{2}$ , and find  $x^2 - 6x + 7 = 2\frac{1}{4} - 9 + 7 = \frac{1}{4}$ ; and this result being positive, we infer the root must be betwixt 2 and  $1\frac{1}{2}$ . And therefore we try  $1\frac{1}{4}$ , and find  $x^2 - 6x + 7 = \frac{49}{16} - \frac{42}{4} + 7 = 3\frac{1}{16} - 10\frac{8}{16} + 7 = \frac{7}{16}$ , which is negative; so that we conclude the root to be betwixt  $1\frac{1}{4}$  and  $1\frac{1}{2}$ . And therefore we try next  $1\frac{1}{8}$ , which giving also a negative result, we conclude the root is betwixt  $1\frac{1}{4}$  (or  $1\frac{2}{8}$ ) and  $1\frac{1}{8}$ . We try therefore  $1\frac{3}{8}$ , and the result being positive, we conclude that the root must be betwixt  $1\frac{2}{8}$  and  $1\frac{3}{8}$ , and therefore is nearly  $1\frac{2}{8}$ .

Or you may approximate more easily by transforming the equation proposed into another whose roots shall be equal to 10, 100, or 1000 times the roots of the former, by p. 106. col. 1. par. 4. and taking the limits greater in the same proportion. This transformation is easy; for you are only to multiply the 2d term by 10, 100, or 1000, the 3d term by their squares, the 4th by their cubes, &c. The equation of the last example is thus transformed into  $x^2 - 600x + 70000 = 0$ , whose roots are 100 times the roots of the proposed equation, and whose limits are 100 and 200. Proceeding as before, we try 150, and find  $x^2 - 600x + 70000 = 22500 - 90000 + 70000 = 2500$ , so that 150 is less than the root. You next try 175, which giving a negative

result must be greater than the root: and thus proceeding, you find the root to be betwixt 158 and 159: from which you infer, that the least root of the proposed equation  $x^2 - 6x + 7 = 0$  is betwixt 1.58 and 1.59, being the hundredth part of the root of  $x^2 - 600x + 70000 = 0$ .

If the cubic equation  $x^3 - 15x^2 + 63x - 50 = 0$  is proposed to be resolved, the equation of the limits will be (by p. 110. col. 2. par. 2.)  $3x^2 - 30x + 63 = 0$ , or  $x^2 - 10x + 21 = 0$ , whose roots are 3, 7; and by substituting 0 for  $x$ , the value of  $x^3 - 15x^2 + 63x - 50$  is negative; and by substituting 3 for  $x$ , that quantity becomes positive.  $x = 1$  gives it negative, and  $x = 2$  gives it positive, so that the root is between 1 and 2, and therefore incommensurable. You may proceed as in the foregoing examples to approximate to the root. But there are other methods by which you may do that more easily and readily; which we proceed to explain.

When you have discovered the value of the root to be less than an unit (as, in this example, you know it is a little above 1), suppose the difference betwixt its real value and the number that you have found nearly equal to it, to be represented by  $f$ : as in this example. Let  $x = 1 + f$ . Substitute this value for  $x$  in the equation, thus,

$$\begin{aligned} x^3 &= 1 + 3f + 3f^2 + f^3 \\ -15x^2 &= -15 - 30f - 15f^2 \\ +63x &= 63 + 63f \\ -50 &= -50 \end{aligned}$$

$$x^3 - 15x^2 + 63x - 50 = -1 + 36f - 12f^2 + f^3 = 0.$$

Now because  $f$  is supposed less than unit, its powers  $f^2, f^3$ , may be neglected in this approximation; so that assuming only the two first terms, we have  $-1 + 36f = 0$ , or  $f = \frac{1}{36} = .027$ ; so that  $x$  will be nearly 1.027.

You may have a nearer value of  $x$  by considering, that seeing  $-1 + 36f - 12f^2 + f^3 = 0$ , it follows that

$$f = \frac{1}{36 - 12f + f^2} = (\text{by substituting } \frac{1}{36} \text{ for } f)$$

$$\text{nearly} = \frac{1}{36 - 12 \times \frac{1}{36} + \frac{1}{36} \times \frac{1}{36}} = \frac{1}{35.2222} = .02803.$$

But the value of  $f$  may be corrected and determined more accurately, by supposing  $g$  to be the difference betwixt its real value and that which we last found nearly equal to it. So that  $f = .02803 + g$ . Then by substituting this value for  $f$  in the equation  $f^3 - 12f^2 + 36f - 1 = 0$ , it will stand as follows,

$$\begin{aligned} f^3 &= 0.000220226 + 0.002357g + 0.08409g^2 + g^3 \\ -12f^2 &= -0.0942816 - 0.67272g - 12g^2 \\ +36f &= 1.00908 + 36g \\ -1 &= -1. \end{aligned} \quad \left. \vphantom{\begin{aligned} f^3 &= 0.000220226 + 0.002357g + 0.08409g^2 + g^3 \\ -12f^2 &= -0.0942816 - 0.67272g - 12g^2 \\ +36f &= 1.00908 + 36g \\ -1 &= -1. \end{aligned}} \right\} = 0$$


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$$= -0.0003261374 + 35.329637g - 11.9195g^2 + g^3 = 0.$$

Of which the first two terms, neglecting the rest, give  $35.329637 \times g = 0.0003261374$ , and  $g = \frac{0.0003261374}{35.329637} = 0.00000923127$ . So that  $f = 0.02803923127$ ; and

$x = 1 + f = 1.02803923127$ ; which is very near the true root of the equation that was proposed.

If still a greater degree of exactness is required, suppose  $b$  equal to the difference betwixt the true value of  $g$  and



and that we have already found, and proceeding as above you may correct the value of  $g$ .

It is not only one root of an equation that can be obtained by this method, but, by making use of the other limits, you may discover the other roots in the same manner. The equation of p. 116. col. 2. par. 1.  $x^3 - 15x^2 + 63x - 50 = 0$ , has for its limits 0, 3, 7, 50. We have already found the least root to be nearly 1.028039. If it is required to find the middle root, you proceed in the same manner to determine its nearest limits to be 6 and 7; for 6 substituted for  $x$  gives a positive, and 7 a negative result. Therefore you may suppose  $x = 6 + f$ , and by substituting this value for  $x$  in that equation, you find  $f^3 + 3f^2 - 9f + 4 = 0$ , so that  $f = \frac{4}{9}$  nearly. Or,

since  $f = \frac{4}{9 - 3f - f^2}$ , it is (by substituting  $\frac{4}{9}$  for  $f$ )  
 $f = \frac{4}{9 - 3 \cdot \frac{4}{9} - \frac{16}{81}} = \frac{324}{807}$ , whence  $x = 6 + \frac{324}{807}$  nearly. Which

value may still be corrected as in the preceding articles. After the same manner you may approximate to the value of the highest root of the equation.

"In all these operations, you will approximate sooner to the value of the root, if you take the three last terms of the equation, and extract the root of the quadratic equation consisting of these three terms."

Then, in p. 116. col. 2. par. 2. instead of the two last terms of the equation  $f^3 - 12f^2 + 36f - 1 = 0$ , if you take the three last, and extract the root of the quadratic  $12f^2 - 36f + 1 = 0$ ; you will find  $f = .028031$ , which is much nearer the true value than what you discover by supposing  $36f - 1 = 0$ .

It is obvious that this method extends to all equations.

"By assuming equations affected with general coefficients, you may, by this method, deduce general rules or theorems for approximating to the roots of proposed equations of whatever degree."

CHAP. XXII. Of the Rules for finding the Number of impossible Roots in an Equation.

THE number of impossible roots in an equation may, for most part, be found by this.

**RULE.** Write down a series of fractions whose denominators are the numbers in this progression, 1, 2, 3, 4, 5, &c. continued to the number which expresses the dimension of the equation. Divide every fraction in the series by that which precedes it, and place the quotients in order over the middle terms of the equation. And, if the square of any term multiplied into the fraction that stands over it gives a product greater than the rectangle of the two adjacent terms, write under the term the sign +, but if that product is not greater than the rectangle, write -; and the signs under the extreme terms being +, there will be as many imaginary roots as there are changes of the sign from + to -, and from - to +.

Thus, the given equation being  $x^3 + px^2 + 3p^2x - 9 = 0$ , I divide the second fraction of the series  $\frac{1}{2}, \frac{2}{3}, \frac{3}{4}$ , &c. by 1. No. 5.

by the first, and the third by the second, and place the quotients  $\frac{1}{2}$  and  $\frac{1}{3}$ , over the middle terms in this manner,

$$\begin{array}{ccccccc} & & \frac{1}{2} & & \frac{1}{3} & & \\ & & + & - & + & - & \\ x^3 & + & px^2 & + & 3p^2x & - & 9 = 0 \end{array}$$

Then because the square of the second term multiplied into the fraction that stands over it, that is,  $\frac{1}{2} \times p^2x^4$ , is less than  $3p^2x^4$  the rectangle under the first and third terms, I place under the second term the sign -; but as  $\frac{1}{3} \times 9p^2x^2 (= 3p^2x^2)$  the square of the third term multiplied into its fraction is greater than nothing, and consequently much greater than  $-9px^2$ , the negative product of the adjoining terms, I write under the third term the sign +. I write + likewise under  $x^3$  and  $-9$  the first and last terms; and finding in the signs, thus marked, two changes, one from + to -, and another from - to +, I conclude the equation has two impossible roots.

When two or more terms are wanting in the equation, under the first of such terms place the sign -, under the second +, under the third -, and so on alternately; only when the two terms to the right and left of the deficient terms have contrary signs, you are always to write the sign + under the last deficient term.

As in the equations

$$\begin{array}{ccccccc} x^5 + ax^4 & * & * & * & + a^5 = 0 \\ + & + & - & + & - & + \\ \text{and } x^5 + ax^4 & * & * & * & - a^5 = 0 \\ + & + & - & + & + & + \end{array}$$

the first of which has four impossible roots, and the other two.

Hence too we may discover if the imaginary roots lie hid among the affirmative, or among the negative roots. For the signs of the terms which stand over the signs below that change from + to -, and - to +, shew, by the number of their variations, how many of the impossible roots are to be reckoned affirmative; and that there are as many negative imaginary roots as there are repetitions of the same sign.

As in the equation

$$\begin{array}{ccccccc} x^5 - 4x^4 + 4x^3 - 2x^2 - 5x - 4 = 0 \\ + & + & - & + & + & + \end{array}$$

the signs (- + -) of the terms  $-4x^4 + 4x^3 - 2x^2$  which stand over the signs + - + pointing out two affirmative roots, we infer that two impossible roots lie among the affirmative; and the three changes of the signs in the equation (+ - + - -) giving three affirmative roots and two negative, the five roots will be one real affirmative, two negative, and two imaginary affirmatives. If the equation had been

$$\begin{array}{ccccccc} x^5 - 4x^4 - 4x^3 - 2x^2 - 5x - 4 = 0 \\ + & + & - & - & + & + \end{array}$$

the terms  $-4x^4 - 4x^3$  that stand over the first variation + -, shew by the repetition of the sign -, that one imaginary root is to be reckoned negative, and the

+                      G g                      terms

terms  $-2x^2 - 5x$  that stand over the last variation  $-+$ , give, for the same reason, another negative impossible root; so that the signs of the equation  $(-+-----)$  giving one affirmative root, we con-

clude that of the four negative roots two are imaginary.

This always holds good, unless, which sometimes may happen, "there are more impossible roots in the equation than are discoverable by the rule."

## A L H

**ALGENEB**, a fixed star of the second magnitude on the right shoulder of Perseus. See **PERSEUS**.

**ALGHER**, or **ALGERI**, a city on the north-west coast of the island of Sardinia, situated in E. long.  $8^{\circ} 40'$ , and N. lat.  $41^{\circ} 30'$ .

**ALGIABARI**, among the Mahometans, the name of a sect of predestinarians. See **PREDESTINATION**.

**ALGIERS**, a kingdom of Africa, situated between  $30^{\circ}$  and  $37^{\circ}$  of N. lat. and between  $1^{\circ}$  W. and  $9^{\circ}$  E. long. It is bounded by the Mediterranean on the north, by the kingdom of Tunis on the east, by mount Atlas on the south, and by the river Mulvia, which separates it from the empire of Morocco, on the west; extending 600 miles, from east to west, along the Babary coast.

The Turks, who are masters of this kingdom, are but few in number in comparison of the Moors, or natives, who have no share in the government. The Arabs, who live in tents, are distinct from either. The dey of Algiers is an absolute, though an elective monarch. He is chosen by the Turkish soldiers only, and is frequently deposed, or even put to death by them.

**ALGIERS** is also the name of the capital of the above-mentioned kingdom, situated near the mouth of the river Safran, on the Mediterranean sea, opposite to the island of Majorca; its E. long. being  $3^{\circ} 27'$ , and its N. lat.  $36^{\circ} 49'$ .

**ALGOIDES**, in botany. See **ZANNICHELLIA**.

**ALGOL**, the name of a fixed star of the third magnitude in the constellation Perseus, otherwise called Medusa's head. See **ASTRONOMY**, *Of the fixed stars*.

**ALGONQUIN**, one of the two principal languages spoken in N. America, viz. from the river of St Lawrence to that of Mississippi; the other which is called Haron, being spoken in Mexico.

**ALGOR**, with physicians, an unusual coldness in any part of the body.

**ALGORITHM**, and arabic word expressive of numerical computation. See **ARITHMETIC**, Chap. I.

**ALGOSAREL**, in botany, an obsolete name of the daucus. See **DAUCUS**.

**ALGUAZIL**, in the Spanish policy, an officer whose business it is to see the decrees of a judge executed.

**ALHAGI**, in botany, the trivial name of a species of hedyfarum. See **HYDESARUM**.

**ALHAMA**, a small town of Granada in Spain, surrounded with hills, and situated about twenty-five miles S. W. of Granada, W. long.  $4^{\circ}$ , N. lat.  $37^{\circ}$ .

**ALHANDAL**, among Arabian physicians, a name used for colocynth. See **COLOCYNTH**.

**ALHEAL**, in botany. See **GALEOPSIS**, **STACHYS**.

## A L I

**ALHENNA**, in botany, a synonyme of the **Lawsonia**. See **LAWSONIA**.

**ALHIDADE**, or **ALIDADE**, a term of Arabic origin, signifying the index or diopter of a mathematical instrument for taking heights and distances. See **DIOPTER**.

**ALJAMEIA**, the name by which the Moriscoes of Spain called the Spanish language.

**ALICANT**, a large sea-port town of Spain, in the province of Valencia, with a very strong castle. It is situated in W. long.  $36'$ , and N. lat.  $38^{\circ} 37'$ .

**ALICATA**, a mountain of Sicily, near the valleys Mazara and Noto, upon which was situated (as is generally thought) the famous Dædalion, where the tyrant Phalaris kept his brazen bull.

**ALICE**, a cape of the Hither Calabria in the kingdom of Naples, called in Latin *Alicium promontorium*.

**ALICES**, an obsolete name of the spots that precede the eruption of the small-pox.

**ALICULA**, in Roman antiquity, a kind of chlamys worn by children, which some call *tunica manicata*.

**ALICUR**, a very small island in the Tuscan sea, about fifteen miles west from the Lipari, on the coast of Sicily.

**ALIDADE** See **ALIDADE**.

**ALIDES**, among the Mahometans, a designation given to the descendants of Ali; between whom and the Omniades, there was a warm dispute about the kaliphate. See **KALIPHATE**.

**ALJEMBUT**, in botany, an obsolete name of a species of mimosa. See **MIMOSA**.

**ALIBI**, in Scots law; when a person pursued for the commission of a crime, labelled to have been committed at a certain place, and upon a certain day, proves in his defence, that he was elsewhere at the time labelled, he is said to have proved *alibi*. See **LAW**, tit. *Crimes*.

**ALIEN**, in Scots law, a person who owes allegiance to a foreign prince; and who, on that account, cannot hold any feudal right in Scotland without being naturalized. See **LAW**, title, *Constitution of heritable rights*.

**ALIEN duty**, an impost laid on all goods imported by aliens, over and above the customs paid for such goods imported by British, and on British bottoms.

**ALIEN-priorities**, a kind of inferior monasteries, formerly very numerous in England, and so called from their belonging to foreign abbeys.

**ALIENABLE**, denotes something that may be alienated. See **ALIENATION**.

**ALIENATION**, in law, denotes the act of making over a man's property in land, tenements, &c. to another person.

ALIE-

**ALIENATION**, in mortmain, is making over lands, tenements, &c. to a body politic, or to a religious house, for which the king's licence must first be obtained, otherwise the lands, &c. alienated will be forfeited. See **MORTMAIN**.

**ALIFANUS**, in botany, a synonyme of the rhexia. See **RHEXIA**.

**ALIFORMIS**, in anatomy, the name of a pair of muscles. See **ANATOMY**, Part II.

**ALIFORMIS processus**, the name given by some to the prominencies of the os cuneiforme. See **ANATOMY**, Part I.

**ALIMA**, a kind of sand found in gold mines, of which they make lead.

**ALIMENT**, whatever promotes the growth or nourishment of animal or vegetable bodies. See **FOOD**.

**Obligation of ALIMENT**, in Scots law, the natural obligation on parents to provide their children with the necessaries of life, &c. See **LAW**, titles, *Marriage*, and *Obligations and contracts in general*.

**ALIMENTARY**, an epithet for every thing that belongs to aliment or food.

**ALIMENTARY debt**, in Scots law, an obligation come under by one person to pay a certain sum annually for the maintenance of another, either gratuitously, in consideration of a sum of money sunk, or by way of wages. See **LAW**, title, *Arrestment and poinding*.

**ALIMENTARY children**, in Roman antiquity, an appellation given to those educated in houses not unlike our hospitals.

**ALIMENTARY law**, among the Romans, that whereby children were obliged to maintain their aged parents.

**ALIMENTATION**, a term used by some writers, particularly Lord Bacon, for what is commonly called nutrition. See **NUTRITION**.

**ALIMONY**, in law. See *Obligation of ALIMENT*.

**ALIMOS**, in botany, an obsolete name of the glycyrrhiza. See **GLYCYRRHIZA**.

**ALIOS-BATON**, in ichthyology, an obsolete name of a species of rana or frog. See **RANA**.

**ALIPILARIUS**, or **ALIPILUS**, in Roman antiquity, a servant belonging to the baths, whose business it was, by means of waxen plasters, and an instrument called *colpilla*, to take off the hairs from the arm-pits, and even arms, legs, &c. this being deemed a point of cleanliness.

**ALIPTA**, in Grecian antiquity. See **IATRALIPTRA**.

**ALIPTERIUM**, in the ancient gymnasia, the same with eleothesium. See **ELEOTHESIUM**.

**ALIPOW montis ceti**, a kind of white turbit, found in Languedoc, used as a purgative. See **TURBITH**.

**ALIQVANT parts**, those parts which one number cannot measure. See **ARITHMETIC**.

**ALIQVOT parts**, those parts which one number can measure. See **ARITHMETIC**.

**ALISE**, or **ALIZE**, a small town of France, in the district of Auxois.

**ALISE**, or **ELISE**, is a small island in the Irish sea, not far from the mull of Galloway.

**ALISMA**, in botany, a genus of the hexandria polygynia class. The characters of the alisma are these.

The calix consists of three pieces or leaves; the flower has three petals; and the seeds are numerous. There are seven species of this plant, viz. the plantago, or great water-plantain, which grows in all the marshy parts of this country; the ranunculoides, or lesser water-plantain; the natans, or creeping water-plantain; the damafonium, or star-headed water-plantain; all of which are natives of Britain: the flava, cordifolia, and subulata, are natives of America.

**ALITES**, in Roman antiquity, a designation given to such birds as afforded matter of auguries by their flight; in which sense they are contradistinguished from those called *oscines*. See **OSCINES**.

**ALIZE**, in geography. See **ALISE**.

**ALKA**, in ornithology. See **ALCA**.

**ALKAHEST**, or **ALCAHEST**, in chemistry, an universal menstruum capable of resolving all bodies into their first principles. Van Helmont pretended he was possessed of such a menstruum; but, however credulous people might be imposed on in his days, the notion is now become as ridiculous as the philosophers stone, the perpetuum mobile, &c. It is likewise used by some authors for all fixed salts volatilized.

**ALKAHESTIC**, an epithet applied to all powerful menstruums.

**ALKALI**, in chemistry, a name for all substances which ferment with acids. See **CHEMISTRY**, *Of Alkalis*, or *alkaline substances*. Alkali originally signified only the salt of the kali.

**ALKALINE**, an epithet for every body which possesses any of the qualities of an alkali.

**ALKALIZATION**, in chemistry, the impregnating any liquor with alkaline bodies.

**ALKALY**. See **ALKALI**.

**ALKANET**, in botany, the English name of the anchusa. See **ANCHUSA**.

**ALKEKENGI**, in botany, a synonyme of several species of the atropa and physalis; it is also the trivial name of a species of the physalis. See **PHYSALIS**, and **ATROPA**.

**ALKERMES**, in pharmacy, a compound cordial medicine made in the form of a confession. The principal ingredient is the kermes. See **KERMES**.

**ALKIN**, a city of Arabia Felix, seven days journey, S. from Mecca.

**ALKOOL**. See **ALCOHOL**.

**ALKY of lead**, a sweet substance obtained by the chemists from lead.

**ALL-HALLOWS**, the same with All-saints. See the next article.

**ALL-SAINTS**, a festival observed by most denominations of Christians, in commemoration of all the saints in general. It is kept on the first of November.

**ALL-SAINTS bay**, or *baia de todos santos*, a spacious harbour near St Salvador in Brazil, in S. America, on the Atlantic Ocean, W. long. 40°, S. lat. 12°.

**ALL-SCULS**, a festival kept in commemoration of all the faithful deceased, on the second of November.

**ALLA**, or **ALLAH**, the name by which all the professors of Mahometanism call the Supreme Being.

The term alla is Arabic, derived from the verb *alah*.

to adore. It is the same with the Hebrew *eloah*, which signifies the *adorable Being*.

**ALLANTOIS**, or **ALLANTOIDES**, a gut-shaped vesicle investing the fœtus of cows, goats, sheep, &c. filled with a liquor conveyed to it from the urachus.

**ALLAY**. See **ALLOY**.

**ALLEGATA**, in Roman antiquity, a kind of subscription used by the emperors, importing the writings to be verified.

**ALLEGATION**, in matters of literature, is the quoting an author in regard to the subject in hand.

**ALLEGIANCE**, in law, denotes the obedience which every subject owes to his lawful sovereign.

*Oath of ALLEGIANCE*, in the British policy, that taken in acknowledgment of the king as a temporal prince; as the oath of supremacy acknowledges him for the supreme head of the church.

**ALLEGORICAL**, a term applied to whatever belongs to, or partakes of, the nature of an allegory. See **ALLEGORY**.

**ALLEGORIST**, one who deals in allegories: such were many of the Christian fathers.

**ALLEGORY**, in composition, consists in chusing a secondary subject, having all its properties and circumstances resembling those of the principal subject, and describing the former in such a manner as to represent the latter. The principal subject is thus kept out of view, and we are left to discover it by reflection. In other words, an allegory is, in every respect, similar to an hieroglyphical painting, excepting only that words are used instead of colours. Their effects are precisely the same: An hieroglyphic raises two images in the mind; one seen, that represents one that is not seen: An allegory does the same; the representative subject is described; and the resemblance leads us to apply the description to the subject represented.

There cannot be a finer or more correct allegory than the following, in which a vineyard is made to represent God's own people the Jews

"Thou hast brought a vine out of Egypt; thou hast cast out the heathen, and planted it. Thou didst cause it to take deep root, and it filled the land. The hills were covered with its shadow, and the boughs thereof were like the goodly cedars. Why hast thou then broken down her hedges, so that all that pass do pluck her? The boar out of the wood doth waste it, and the wild beast doth devour it. Return, we beseech thee, O God of hosts: look down from heaven, and behold, and visit this vine and the vineyard thy right hand hath planted, and the branch thou madest strong for thyself." Psa. lxxx.

Nothing gives greater pleasure than an allegory, when the representative subject bears a strong analogy, in all its circumstances, to that which is represented. But most writers are unlucky in their choice, the analogy being generally so faint and obscure, as rather to puzzle than to please. Allegories, as well as metaphors and similes, are unnatural in expressing any severe passion which totally occupies the mind. For this reason, the following speech of Macbeth is justly

condemned by the learned author of the *Elements of Criticism*:

Methought I heard a voice cry, Sleep no more!  
Macbeth doth murder Sleep; the innocent sleep;  
Sleep that knits up the ravell'd sleeve of Care,  
The birth of each day's life, fore Labour's bath,  
Balm of hurt minds, great Nature's second course,  
Chief nourisher in life's feast. Act ii. Sc. 3.

**ALLEGRO**, in music, an Italian word, denoting that the part is to be played in a sprightly, brisk, lively, and gay manner.

*Piu ALLEGRO*, signifies, that the part it is joined to should be sung or played quicker; as

*Poco piu ALLEGRO*, intimates, that the part to which it refers, ought to be played or sung only a little more briskly than allegro alone requires.

**ALLEGRET**. See **ALEGRETTE**.

**ALLELENGYON**, in antiquity, a tax paid by the rich for the poor, when absent in the army.

**ALLELOPHAGI**, a term used by some authors for a kind of flies which are said to feed upon each other.

**ALLELUJAH**, in botany, an obsolete name for the oxys. See **OXYS**.

**ALLELUJAH**, among ecclesiastical writers. See **HALLELUJAH**.

**ALLEMAND**, a sort of grave solemn music, with good measure, and a slow movement. It is also a brisk kind of dance, very common in Germany and Switzerland.

**ALLEMANNIC**, in a general sense, denotes any thing belonging to the ancient Germans. Thus, we meet with Allemannic history, Allemannic language, Allemannic law, &c.

**ALLENDORF**, a little city in the Landgravate of Hesse-Cassel in Germany, situated upon the river Weser; E. long. 10°, N. lat. 51° 30'.

**ALLER**, a river which runs through the Dutchy of Lunenburg, and falls into the Weser, a little below Verden.

**ALLER**, or **ALDER**, a term used in our old writers to denote the superlative degree. Thus, *aller-good* signifies the greatest good.

**ALLERION**, or **ALERTION**, in heraldry, a sort of eagle without beak or feet, having nothing perfect but the wings. They differ from martlets by having their wings expanded, whereas those of the martlet are close; and denote imperialists vanquished and disarmed; for which reason they are more common in French than in German coats of arms.

**ALEU**, or **ALLODE**. See **ALLODIAL**, and **ALLODIUM**.

**ALLEVIARE**, in old records, signifies to levy or raise an accustomed fine or imposition

**ALLEVIATION**, is the act of making a thing lighter, or more easy to be borne.

**ALLEVEURE**, a small brass Swedish coin, worth about  $2\frac{1}{4}$  English money.

**ALLEY**, in gardening, a straight parallel walk, bounded on both sides with trees, shrubs, &c. and usually covered with gravel or turf.

*Covered*

*Covered* ALLEY, that over which the branches of trees meeting, form a shade.

ALLEY of *compartment*, that which divides the squares of a *parterre*. See *PARTERRE*.

ALLEY, among builders, denotes a narrow passage leading from one place to another.

ALLEY, in perspective, that which, in order to have a greater appearance of length, is made wider at the entrance than at the termination.

ALLIANCE, in the civil and canon law, the relation contracted between two persons or two families by marriage.

ALLIANCE is also used for a treaty entered into by sovereign princes and states, for their mutual safety and defence.

In this sense, alliances may be distinguished into such as are offensive, whereby the contracting parties oblige themselves jointly to attack some other power; and into defensive ones, whereby they bind themselves to stand by and defend each other, in case they are attacked by others.

ALLIANCE, in a figurative sense, is applied to any kind of union or connection: thus we say, there is an alliance between the church and state.

ALLIGATI, in Roman antiquity, the basest kind of slaves, who were usually kept fettered. See *SLAVE*.

ALLIER, a river of France, which, arising in Languedoc, waters part of Auvergne and Bourbonnois, and falls into the Loire, a little below Nevers.

## A L L I G A T I O N .

**A**LLIGATION, the name of a method of solving all questions that relate to the mixture of one ingredient with another. Though writers on arithmetic generally make alligation a branch of that science; yet, as it is plainly nothing more than an application of the common properties of numbers, in order to solve a few questions that occur in particular branches of business, we chuse rather to keep it distinct from the science of arithmetic.

Alligation is generally divided into *medial* or *alterate*.

### I. ALLIGATION MEDIAL.

Alligation medial, from the rates and quantities of the simples given, discovers the rate of the mixture.

**RULE.** As the total quantity of the simples,  
To their price or value;  
So any quantity of the mixture,  
To the rate.

**EXAMP.** A grocer mixeth 30 lb. of currants, at 4d. per lb. with 10 lb. of other currants, at 6d. per lb.: What is the value of 1 lb. of the mixture. *Ans.* 4½d.

lb.	d.		d.
30,	at 4	amounts to	120
10,	at 6	_____	60
40			180

If 40 : 180 :: 1 : 4½

**Note 1.** When the quantity of each simple is the same, the rate of the mixture is readily found by adding the rates of the simples, and dividing their sum by the number of simples, thus.

Suppose a grocer mixes several sorts of sugar, and of

each an equal quantity, viz. at 50 s. at 54 s. and at 60 s. per C<sup>wt</sup>. the rate of the mixture will be 54 s. 8 d. per C<sup>wt</sup>.; for,

$$50 + 54 + 60 = 164, \text{ and } 3)164(54 \text{ } 8$$

**Note 2.** If it be required to increase or diminish the quantity of the mixture, say, As the sum of the given quantities of the simples, to the several quantities given; so the quantity of the mixture proposed, to the quantities of the simples sought.

**Note 3.** If it be required to know how much of each simple is in an assigned portion of the mixture, say, As the quantity of the mixture, to the several quantities of the simples given; so the quantity of the assigned portion, to the quantities of the simples sought. Thus,

Suppose a grocer mixes 10 lb. of raisins, with 30 lb. of almonds, and 40 lb. of currants, and it be demanded, how many ounces of each sort are found in every pound, or in every sixteen ounces of the mixture, say,

oz.			
80 :	10 ::	16 :	2 raisins.
80 :	30 ::	16 :	6 almonds.
80 :	40 ::	16 :	8 currants.

### Proof 16

**Note 4.** If the rates of two simples, with the total value and total quantity of the mixture be given, the quantity of each simple may be found as follows, viz. multiply the lesser rate into the total quantity, subtract the product from the total value, and the remainder will be equal to the product of the excess of the higher rate above the lower, multiplied into the quantity of the higher-priced simple; and consequently the said remainder, divided by the difference of the rates, will quote the said quantity. Thus,

Suppose a grocer has a mixture of 400 lb weight, that cost him 7l. 10s. consisting of raisins, at 4d. per lb.

† H h and

and almonds at 6 d. how many pounds of almonds were in the mixture?

	<i>lb.</i>	<i>Rates.</i>	
	400	6 d.	
<i>L. s. d.</i>	4	4 d.	
7 10 = 1800			
1600	1600 d.	2 d.	
<hr/>			
2)200(100 lb. of almonds at 6 d. is,			<i>L. s.</i> 2 10
And 300 lb. of raisins, at 4 d. is,			5 0
<hr/>			
Total 400			Proof 7 10

II. ALLIGATION ALTERNATE.

Alligation alternate, being the converse of alligation medial, from the rates of the simples, and rate of the mixture given, finds the quantities of the simples.

R U L E S.

I. Place the rate of the mixture on the left side of a brace, as the root; and on the right side of the brace set the rates of the several simples, under one another, as the branches.

II. Link or alligate the branches, so as one greater, and another less than the root may be linked or yoked together.

III. Set the difference betwixt the root and the several branches, right against their respective yoke-fellows. These alternate differences are the quantities required.

*Note 1.* If any branch happen to have two or more yoke-fellows, the difference betwixt the root and these yoke-fellows must be placed right against the said branch, one after another, and added into one sum.

*Note 2.* In some questions, the branches may be alligated more ways than one; and a question will always admit of so many answers, as there are different ways of linking the branches.

Alligation alternate admits of three varieties, viz.

1. The question may be unlimited, with respect both to the quantity of the simples, and that of the mixture.
2. The question may be limited to a certain quantity of one or more of the simples.
3. The question may be limited to a certain quantity of the mixture.

Variety I.

When the question is unlimited, with respect both to the quantity of the simples, and that of the mixture, this is called *Alligation Simple*.

*EXAMP.* A grocer would mix sugars, at 5 d. 7 d. and 10 d. per lb. so as to sell the mixture or compound at 8 d. per lb: What quantity of each must he take?

		<i>lb.</i>	
8	{	5	2
		7	2
		10	3, 1
			4

Here the rate of the mixture 8 is placed on the left

side of the brace, as the root; and on the right side of the same brace are set the rates of the several simples, viz. 5, 7, 10, under one another, as the branches; according to Rule I.

The branch 10 being greater than the root, is alligated or linked with 7 and 5, both these being less than the root; as directed in Rule II.

The difference between the root 8 and the branch 5, viz. 3, is set right against this branch's yoke-fellow 10. The difference between 8 and 7 is likewise set right against the yoke-fellow 10. And the difference betwixt 8 and 10, viz. 2, is set right against the two yoke-fellows 7 and 5; as prescribed by Rule III.

As the branch 10 has two differences on the right, viz. 3 and 1, they are added; and the answer to the question is, that 2 lb. at 5 d. 2 lb. at 7 d. and 4 lb. at 10 d. will make the mixture required.

The truth and reason of the rules will appear by considering, that whatever is lost upon any one branch is gained upon its yoke-fellow. Thus, in the above example, by selling 4 lb. of 10 d. sugar at 8 d. per lb. there is 8 d. lost: but the like sum is gained upon its two yoke-fellows; for by selling 2 lb. of 5 d. sugar at 8 d. per lb. there is 6 d. gained; and by selling 2 lb. of 7 d. sugar at 8 d. there is 2 d. gained; and 6 d. and 2 d. make 8 d.

Hence it follows, that the rate of the mixture must always be mean or middle with respect to the rates of the simples; that is, it must be less than the greatest, and greater than the least; otherwise a solution would be impossible. And the price of the total quantity mixed, computed at the rate of the mixture, will always be equal to the sum of the prices of the several quantities, cast up at the respective rates of the simples.

Variety II.

When the question is limited to a certain quantity of one or more of the simples, this is called *Alligation Partial*.

If the quantity of one of the simples only be limited, alligate the branches, and take their differences, as if there had been no such limitation; and then work by the following proportion.

As the difference right against the rate of the simple whose quantity is given,  
 To the other differences respectively;  
 So the quantity given,  
 To the several quantities sought.

*EXAMP.* A distiller would, with 40 gallons of brandy at 12 s. per gallon, mix rum at 7 s. per gallon, and gin at 4 s. per gallon: How much of the rum and gin must he take, to sell the mixture at 8 s. per gallon?

		<i>Gal.</i>	
8	{	12	5
		7	4
		4	4
			4

} *Ans.*  
 40 of brandy.  
 32 of rum.  
 32 of gin.

The operation gives for answer, 5 gallons of brandy, 4 of

4 of rum, and 4 of gin. But the question limits the quantity of brandy to 40 gallons; therefore say,

$$\text{If } 5 : 4 :: 40 : 32$$

The quantity of gin, by the operation, being also 4, the proportion needs not be repeated.

*Variety III.*

When the question is limited to a certain quantity of the mixture, this is called *Alligation Total*.

After linking the branches, and taking the differences, work by the proportion following,

As the sum of the differences,  
To each particular difference;  
So the given total of the mixture,  
To the respective quantities required.

EXAMP. A vintner hath wine at 3 s. per gallon, and

would mix it with water, so as to make a composition of 144 gallons, worth 2s. 6d. per gallon: How much wine, and how much water must he take?

$$\begin{array}{r|l} \text{Gal.} & \\ 30 \left\{ \begin{array}{l} 36 \\ 0 \end{array} \right. \begin{array}{l} 30 \\ 6 \end{array} & \left. \begin{array}{l} 120 \text{ of wine.} \\ 24 \text{ of water.} \end{array} \right\} \text{Ans.} \\ \hline 36 & 144 \text{ total.} \\ 120 \times 36 = & 4320 \\ 24 \times 0 = & 0 \\ \hline \text{Proof } 144)4320(30 & \end{array}$$

$$\begin{array}{l} \text{As } 36 : 30 :: 144 : 120 \\ \text{As } 36 : 6 :: 144 : 24 \end{array}$$

There being here only two simples, and the total of the mixture limited, the question admits but of one answer.

A L L

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**ALLIGATOR**, in zoology, a synonyme of the lacerta crocodilus. See LACERTA.

**ALLIGATOR-pear**, in botany. See PYRUS.

**ALLIONIA**, in botany, a genus of the tetrandria monogynia class. The characters of which are: The common calix is oblong, simple, and three flowered; the proper calix is above the fruit, and obsolete; the corolla is irregular; and the receptacle without any covering. There are only two species of the allionia, viz. the violacea, and incarnata, both natives of America.

**ALLIOTH**, a star in the tail of the greater bear, much used for finding the latitude at sea.

**ALLIUM** garlick, in botany, a genus of the hexandria monogynia class. The characters are: The corolla is open, and divided into six parts; the spathe is multiflorous; the capsule is above the flower; and the flowers are in the form of an umbell. There are no less than 37 species of the allium, only five of which, viz. the ampeloprasum, or great round-headed garlick; the arenarium, or broad-leaved mountain-garlick; the vineale, or crow-garlick; the oleraceum, or wild garlick with an herbaceous striated flower; and the ursinum, or ramson, are natives of Britain. Allium is a powerful diuretic, and, along with honey, has good effects in asthma.

**ALLOA**, a port-town of Scotland, situated on the river Forth, remarkable for the coal-mines in its neighbourhood. W. long. 3° 45', N. lat. 56° 10'.

**ALLOCATION** denotes the admitting or allowing of an article of an account, especially in the exchequer. Hence,

*Allocacione facienda* is a writ directed to the lord treasurer, or barons of the exchequer, commanding them to allow an accountant such sums as he has lawfully expended in the execution of his office.

**ALLOCATO comitatu**, a new writ of exigent allowed, before any other county court held, on a former not being complied with. See EXIGENT.

**ALLOCUTION**, in Roman antiquity, denotes an harangue made by a general to his army, frequently mentioned on ancient medals.

**ALLODIAL goods**, in Scots law, are such as are enjoyed by the owner, independent of any other. Lands are likewise said to be allodial, when they are held without the necessity of acknowledging a superior. See LAW, title, *Constitution of heritable rights*.

**ALLODIUM**, or **ALLEUD**, denotes lands which are the absolute property of their owner, without being obliged to pay any service or acknowledgement whatever to a superior lord.

**ALLOGIA**, a term found in old writers on military affairs, for winter-quarters.

**ALLOM**. See ALUM.

**ALLONGE**, in fencing, denotes a thrust or pass at the adversary. See PASS.

**ALLOPHYLLUS**, in botany, a genus of the octandria monogynia class. The characters are: The calix is four leaved; the leaves are globular; the flower consists of four petals, less than the calix; and the stigma is forked. There is only one species, which is found in Zeylon.

**ALLOTTING**, or **ALLOTMENT of goods**, in commerce, is the dividing a ship's cargo into several parts, which are to be purchased by several persons, whose names being written upon as many slips of paper, are applied by an indifferent person to the several lots; by which means the goods are divided without partiality, each man having the parcel upon which his name is fixed.

**ALLOWANCES**, at the custom-house, to goods rated by weight, are two, viz. draught and tare. See DRAUGHT and TARE.

**ALLOY**, or **ALLAY**, a proportion of a baser metal mixed with a finer one. Thus all gold coin has an alloy of silver and copper, as silver coin has of copper alone; the proportion in the former case, for standard gold, being two carrats of alloy in a pound troy of gold;

- gold; and, in the latter, eighteen penny-weight of alloy for a pound of silver.
- ALLUM.** See **ALUM.**
- ALUMNIOR**, in some of our old statutes, a person whose trade it is to colour, or paint upon paper or parchment.
- ALLUSION**, in rhetoric, a figure by which something is applied to, or understood of another, on account of some similitude between them.
- ALLUVION**, in law, denotes the gradual increase of land along the sea-shore, or on banks of rivers. See **LAW**, title, *Division of rights*.
- ALLY**, in matters of polity, a sovereign prince or state that has entered into alliance with others. See **ALLIANCE**.
- ALMACANTARS.** See **ALMUCANTARS.**
- ALMACARRON**, a port-town of Spain, in the province of Murcia, at the mouth of the Guadalentin; W. long.  $1^{\circ} 15'$ , N. lat.  $37^{\circ} 40'$ .
- ALMADE**, a town of Spain, in the province of la Mancha, in the kingdom of Castile, situated upon the top of a mountain, where are the most ancient, as well as the richest silver mines in Europe.
- ALMADIE**, a kind of canoe, or small vessel, about four fathoms long, usually made of bark, and used by the negroes of Africa.
- ALMADIE** is also the name of a kind of long boats, fitted out at Calicut, which are eighty feet in length, and six or seven in breadth. They are exceeding swift, and are otherwise called *cathuri*.
- ALMAGEST**, in matters of literature, is particularly used for a collection or book composed by Ptolemy, containing various problems of the ancients both in geometry and astronomy.
- ALMAGEST** is also the title of other collections of this kind. Thus, Riccioli has published a book of astronomy which he calls the *New Almagest*; and Pluckenet, a book which he calls *Almagestrum Botanicum*.
- ALMAGRA**, a fine deep red ochre. See **OCBRE**.
- ALMAN-FURNACE**, the same with almond-furnace. See **ALMOND**.
- ALMANAC**, in matters of literature, a table containing the kalendar of days and months, the rising and setting of the sun, the age of the moon, &c.
- Regiomontanus is allowed to have been the first who reduced almanacs to their present form.
- Construction of ALMANACS.** The first thing to be done is, to compute the sun's and moon's place for each day of the year, or it may be taken from some ephemerides and entered in the almanac; next, find the dominical letter, and, by means thereof, distribute the kalendar into weeks; then, having computed the time of easter, by it fix the other moveable feasts; adding the immoveable ones, with the names of the martyrs, the rising and setting of each luminary, the length of day and night, the aspects of the planets, the phases of the moon, and the sun's entrance into the cardinal points of the ecliptic, *i. e.* the two equinoxes and solstices.
- ALMANDINE**, a name given by ancient naturalists to the carbuncle. See **CARBUNCLE**.
- ALMANZA**, a little town in the province of New Castile in Spain, remarkable for the defeat of the confederate army by the French, in 1707; W. long.  $1^{\circ} 19'$ , N. lat.  $39^{\circ}$ .
- ALMARIA**, a term found in some ancient records for the archives of a church, monastery, and the like.
- ALMARIC heresy**, one broached in France in 1209, the distinguishing tenet of which was, That no Christian could be saved unless he believed himself to be a member of Christ.
- ALMEDA**, a town in the province of Beira in Portugal; W. long.  $9^{\circ} 40'$ , N. lat.  $38^{\circ} 40'$ .
- ALMEDIA**, a frontier town in the province of Trallos Montes, in Portugal; W. long.  $7^{\circ} 10'$ , N. lat.  $40^{\circ} 40'$ .
- ALMEHRAB**, in the Mahometan customs, a nich in their mosques, pointing towards the kebla or temple of Mecca, to which they are obliged to bow in praying. See **KEBLA**.
- ALMELILETU**, a term used by Avicenna, for a preternatural heat which sometimes remains after a fever is gone.
- ALMENE**, in botany, an obsolete name of the lotus. See **LOTUS**.
- ALMENE**, in commerce, a weight of two pounds used to weigh saffron in several parts of the continent of the E. Indies.
- ALMENDINE, ALMENDINE, or ALBANDINE**, a species of ruby. See **RUBY**.
- ALMERIA**, a sea-port town of Spain in the kingdom of Granada, situated at the mouth of the river Almorria, or Bolciduy.
- ALMERY.** See **AMBERY**.
- ALMIGGIM-wood**, is thought to be that of the Indian pine-tree, which being light and white, was greatly esteemed for making musical instruments.
- ALMISSA**, a city of Dalmatia, subject to the Venetians, and called by the Slavonians Omisch.
- ALMIZADIR**, an obsolete term among chemists for verdigris, &c.
- ALMODIA**, a kind of very long and narrow boat, used in the E. Indies.
- ALMOGIZA**, a term used by Arabian writers for the limb of the astrolabe. See **ASTROLABE**.
- ALMOIN, or Frank-ALMOIN**, in law. See **Frank-ALMOIN**.
- ALMOND**, the fruit of the almond-tree. See **AMYGDALUS**.
- ALMOND-tree.** See **AMYGDALUS**.
- Egyptian ALMOND**, in botany. See **BRABEJUM**.
- ALMOND**, in commerce, a measure by which the Portuguese sell their oil; twenty-six almonds make a pipe.
- ALMONDS**, in anatomy. See **AMYGDALÆ**.
- ALMOND-furnace**, among refiners, that in which the slags of litharge, left in refining silver, are reduced to lead again, by the help of charcoal.
- ALMOND** is also the name of a species of rock-crystal, used by lapidaries in adorning candlesticks, &c. on account of their resemblance to the fruit of that name.
- ALMONDBURY**, a village in England, in the west riding of Yorkshire, six miles from Hallifax.



- ALMONER**, an officer appointed to distribute alms to the poor.
- ALMONRY, AUMBRY, AMBRY.** See **AMBRY.**
- ALMS**, a general term for what is given out of charity to the poor.
- In the early ages of Christianity, the alms of the charitable were divided into four parts; one of which was allotted to the bishop, another to the priests, and a third to the deacons and sub-deacons, which made their whole subsistence; the fourth part was employed in relieving the poor, and in repairing the churches.
- ALMS**, also denotes lands or other effects left to churches or religious houses, on condition of praying for the soul of the donor. Hence,
- Free ALMS* was that which is liable to no rent or service.
- Reasonable ALMS* was a certain portion of the estates of intestate persons, allotted to the poor.
- ALMS-box**, or **ALMS-chest**, in churches, and hospitals, &c. a strong box, with a hole or slit in the upper part, to receive the alms of the charitably disposed.
- ALMS-feeth**, or **ALMS-feoth**, a term anciently used for Peter's pence. See **PETER'S PENCE.**
- ALMS-house**, a kind of hospital for the maintenance of a certain number of poor, aged, or disabled persons.
- ALMSTAD**, a town of Sweden, in the province of Smaland, four miles E. of Christianstad.
- ALMOKARIFARGO**, an old duty paid upon the British woollen manufactures in old Spain: Also a duty of  $2\frac{1}{2}$  per cent. paid in Spanish America, upon the exportation of bulls hides in European vessels.
- ALMUCANTARS**, in astronomy, an Arabic word denoting circles of the sphere passing through the center of the sun, or a star, parallel to the horizon, being the same as parallels of altitude. See *Parallels of ALTITUDE.*
- ALMUCIUM**, denotes a kind of cover for the head, worn chiefly by monks and ecclesiastics: It was of a square form, and seems to have given rise to the bonnets of the same shape, still retained in universities and cathedrals.
- ALMUCIA**, is sometimes also used for the furs, or muffs, worn by the ancient canons on their left arms.
- ALMUG-TREE**, mentioned in Scripture, is supposed to be the same with that which produces the gum arabic.
- ALMUNECAR**, a port-town of Granada, in Spain, situated upon the Mediterranean: W. long.  $3^{\circ} 45'$ . N. lat.  $36^{\circ} 40'$ .
- ALMUTAZAPHUS**, a magistrate of Arragon, whose office it was to inspect measures and weights, and search houses for stolen goods.
- ALMUTHEN**, in astrology, the planet which surpasses the rest with respect to dignities. See **DIGNITY.**
- ALNABATI**, in botany, an obsolete name of the siliqua. See **SILICUA.**
- ALNAGE**, or **AULNAGE**, in the English polity, the measuring of woollen manufactures with an ell, and the other functions of the alnager.
- ALNAGER**, in the English polity, a public sworn officer, whose business is to examine into the assize of all woollen cloth made throughout the kingdom, and
- fix seals upon them. Another branch of his office is to collect an alnage-duty to the king.
- ALNAM**, in botany, an obsolete name of the Pulegium. See **PULEGIUM.**
- ALNEY**, a small island formed by the branches of the Severn, near Gloucester, in England; called also the **Eight.**
- ALNUS**, in botany, a synonyme of a species of betula, or alder-tree. See **BETULA.**
- ALNUS**, in the ancient theatres, that part which was most distant from the stage.
- ALNWICK**, the county-town of Northumberland, in England, situated upon the alne.
- ALOA**, in Grecian antiquity, a festival kept in honour of Ceres by the husbandmen, and supposed to resemble our harvest-home.
- ALOE**, in botany, a genus of the hexandria monogynia class. The characters are: The corolla is erect, open at the top, and the nectarium at the bottom of it; the filaments of the stamina are inserted in the receptacle, the leaves are thick, succulent, and for the most part beset with bristles; the fruit is oblong and cylindrical, and divided into three cells, which contain flat semicircular seeds. There are eight species of the aloe, viz. the perfoliata, variegata, disticha, spiralis, viscosa, pumila, uvaria, and retusa, most of them natives of Africa. The retusa, or pearl aloe, is a very beautiful plant. It is smaller than most of the aloe kind. The leaves are short, very thick, sharp pointed, and turning down with a large thick end, appear there triangular. The colour of the leaves is a fine green, striped in an elegant manner with white, and frequently tipped with red at the point. The flower-stalk, which rises in the midst of the leaves, is round, smooth, of a purple colour, and generally about eight inches high. When the plant has been properly cultivated, the flowers are striped with green and white; and sometimes they are entirely white. This aloe is singular in not having the bitter resinous juice with which the leaves of most others abound; when a leaf of this species is cut, what runs from it is watery, colourless, and perfectly inspid. Linnæus says that this plant thrives best in a clay soil, and that it grows wild in the clay-grounds of Africa. See plate XI. fig. 1.
- The inspissated juice of the aloe is a stimulating cathartic bitter, and is used in various forms, for cleansing the primæ viæ, attenuating and resolving viscid juices, for promoting the uterine and hæmorrhoidal fluxes, killing worms, &c.
- ALOE-WOOD.** See **XYLO-ALOES.**
- ALOE-DARY**, an obsolete name of a purging medicine, whose chief ingredient is aloes.
- ALOE-TICS**, the name of all medicines whose chief ingredient is aloes.
- ALOGIANS**, in church-history, a sect of ancient heretics, who denied that Jesus Christ was the Logos, and consequently rejected the gospel of St. John.
- ALOGOTROPHIA**, among physicians, the unequal growth or nourishment of any part of the body, as in the rickets.

**ALOIDES**, in botany, an obsolete name of the stratiotes. See **STRATIOTES**.

**ALOOF**, in sea-language, a word of command from the person who conns to the man at the helm, to keep the ship near the wind, when sailing upon a quarter-wind.

**ALOPECIA**, in medicine, signifies a falling off of the hair, occasioned either by want of nourishment, or a bad state of the humours. It is also used by Galen for a change in the colour of the hair.

**ALOPECIAS**, in zoology, an obsolete name of a species of the squalus or shark. See **SQUALUS**.

**ALOPECOPITHECUS**, in zoology, an obsolete name of a species of the didelphis. See **DIDELPHIS**.

**ALOPECURUS**, or **FOX-TAIL GRASS**, in botany, a genus of the triandria digynia class. The calix is bivalved, and the flower consists of one hollow valve, with a long awn inserted near the base on the back part. There are seven species of the alopecurus, viz. the pratensis, or meadow fox-tail grass; the bulbosus, or bulbose fox-tail grass; the geniculatus, or stote fox-tail grass; and the myosuroides, or field fox-tail grass; the above four grow wild in Britain: the regalis, the monspeliensis, the paniceus, and the hordeiformis, all natives of France, and the southern parts of Europe, except the last, which is a native of India.

**ALOSA**, the shad, or mother of herrings, a species of the clupea. See **CLUPEA**.

**ALOST**, a town in the Austrian Flanders, upon the river Dender, half-way between Brussels and Ghent.

**ALP**, in ornithology, an obsolete name of a species of the loxia. See **LOXIA**.

**ALPHA**, among grammarians, the name of the first letter of the greek alphabet, answering to our A.

**ALPHABET**, in matters of literature, the natural or accustomed series of the several letters of a language. See **LANGUAGE**, and **CHARACTER**.

**ALPHABET**, is also used for a cypher, or table of the usual letters of the alphabet, with the corresponding secret characters, and other blank symbols intended to render the writing more difficult to be decyphered. See **DECYPHERING**.

**ALPHABETICAL**, something belonging to, or partaking of the nature of an alphabet. Thus we say, alphabetical order, method, &c.

**ALPHENIC**, a name sometimes used for white barley-sugar, or twisted sugar.

**ALPHESERA**, in botany, an obsolete name of a species of bryonia. See **BRYONIA**.

**ALPHESTES**, in ichthyology, an obsolete name of a species of labrus. See **LABRUS**.

**ALPHETA**, in astronomy, the same with lucida coronæ. See **LUCIDA CORONÆ**.

**ALPHITIDION**, a term for a fracture, wherein the bone is crushed to pieces.

**ALPHITOMANCY**, a species of divination, otherwise called aleuromancy. See **ALEUROMANCY**.

**ALPHONSIN**, in surgery, an instrument used in extracting bullets, in gun-shot-wounds. See **SURGERY**, *Of Gun-shot wounds*.

**ALPHONSINE TABLES**, astronomical tables, cal-

culated by order of Alphonfus king of Castile, in the construction of which that prince is supposed to have contributed his own labour.

**ALPHOS**, among physicians, a disease of the skin, which is rough, and sprinkled with white spots.

**ALPINE**, something belonging to the Alps. See **ALPS**.

**ALPINIA**, in botany, a genus of the monandria monogynia class, of which there is but one species. The flower is tubulous, and divided into six segments; the capsule, which becomes a fruit, is divided into three cells, each containing one seed. It is a native of America.

**ALPS**, a chain of exceeding high mountains, separating Italy from France and Germany.

**ALQUIER**, a liquid measure, used in Portugal to measure oil, two of which make an almond. See **ALMOND**.

**ALRAMECH**, in astronomy, the name of a star of the first magnitude, otherwise called arcturus. See **ARCTURUS**, and **ASTRONOMY**.

**ALRUM**, in botany, an obsolete name of the tree from which the gum bdellium is procured. See **BDELLIUM**.

**ALSACE**, a province formerly belonging to Germany, but almost entirely ceded to France by the peace of Munster; is situated between the river Rhine on the east, and Lorrain on the west, Switzerland on the south, and the palatinate of the Rhine on the north.

**ALSADAF**, in materia medica, an obsolete name of the unguis odoratus. See **UNGUIS**.

**ALSAHARATICA**, in botany, an obsolete name of the parthenium. See **PARTHENIUM**.

**ALSEN**, an island in the lesser belt, at the entrance of the Baltic sea, between Sleswic and Funen. E. long. 10° 12', N. lat. 55° 12'.

**ALSCHARCUR**, in materia medica. See **SKINK**.

**ALSFIELD**, or **ASFIELD**, a town of Hesse Cassel, in Germany. E. long. 9° 5'. N. lat. 50° 40'.

**ALSIMBEL**, in botany, an obsolete name of a species of nardus. See **NARDUS**.

**ALSINA**, in botany, a synonyme of the theligonum. See **THELIGONUM**.

**ALSINASTRUM**, in botany, the trivial name and also a synonyme of the elatine. See **ELATINE**.

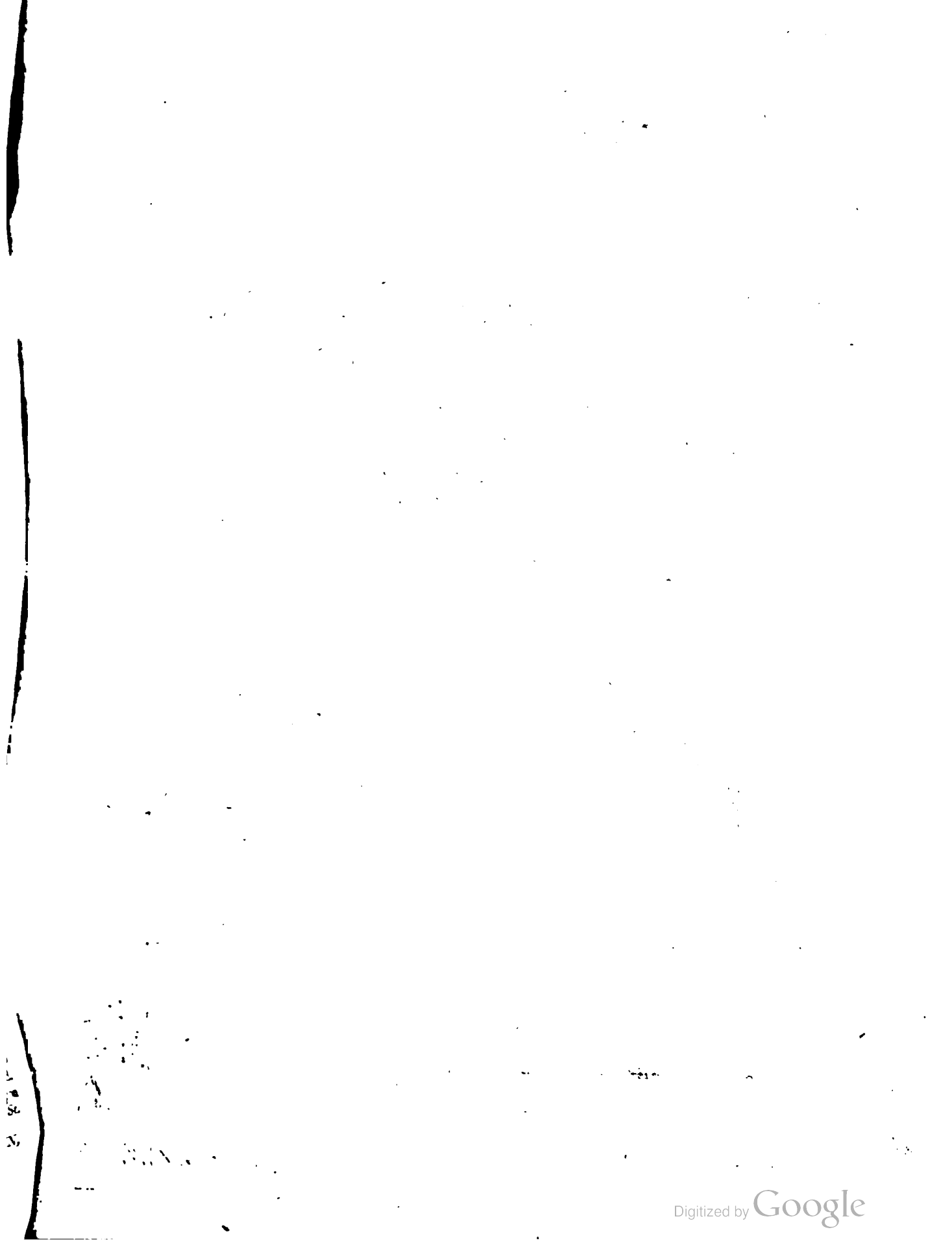
**ALSINE**, *Chickweed*, in botany, a genus of the pentandria trigynia class: The calix is divided into five parts; the flowers consist of five petals divided in the middle; and the capsule has three valves. There are three species of the alsine, viz. the media, or common chickweed, a native of Britain; the mucronata, a native of Switzerland; and the segetalis, a native of France.

The alsine media has sometimes been recommended in hysterical cases.

**ALSIRAT**, in the Mahometan theology, denotes a bridge laid over the middle of hell, the passage or path whereof is sharper than the edge of a sword; over which every body must pass at the day of judgement, when the wicked will tumble headlong into hell, whereas the good will fly over it like the wind:

**ALSONE**, a small city of Languedoc in France, upon the river Fresquel, between Carcassone and St. Papoul.

**ALSWANGEN**,



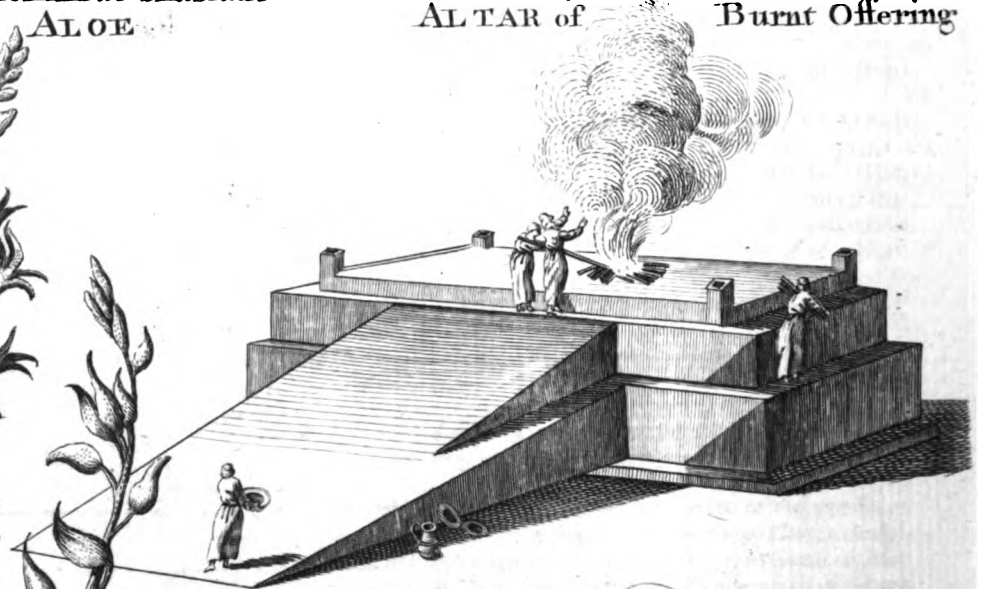
*Fig. 1.*

ALOE floribus sessilibus bilabiatis  
or PEARL ALOE



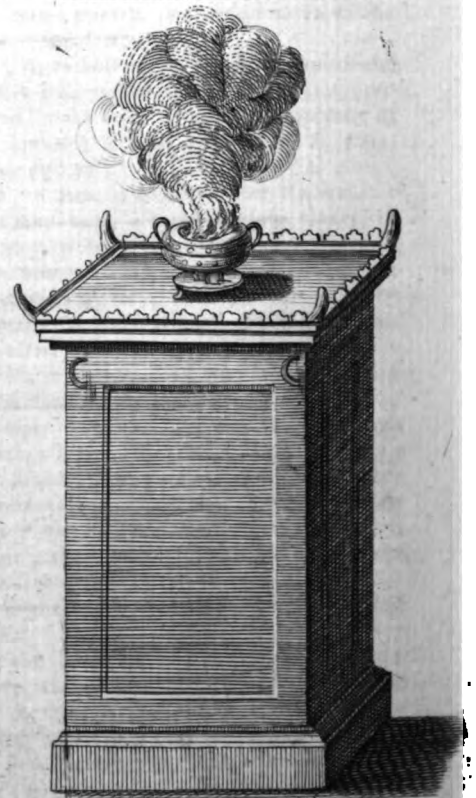
*Fig. 2.*

ALTAR of Burnt Offering



*Fig. 3.*

ALTAR of Incense



*A. Bell Sculp.*

**ALSWANGEN**, a town of Livonia, in the dutchy of Courland, situated upon the Baltic.

**ALT**, in music, a term applied to the high notes in the scale. See **MUSIC**.

**ALTAMURA**, a city in the kingdom of Naples, at the foot of the Apennines. E. long. 17°. N. lat. 41°.

**ALTAR**, a place upon which sacrifices were anciently offered to some deity.

The heathens at first made their altars only of turf; afterwards they were made of stone, of marble, of wood, and even of horn, as that of Apollo in Delos. Altars differed in figure as well as in materials. Some were round, others square, and others oval. All of them were turned towards the east, and stood lower than the statues of the gods, and were generally adorned with sculpture, inscriptions, and the leaves and flowers of the particular tree consecrated to the deity. Thus, the altars of Jupiter were decked with oak, those of Apollo with laurel, those of Venus with myrtle, and those of Minerva with olive.

The height of altars also differed according to the different gods to whom they sacrificed. Those of the celestial gods were raised to a great height above the ground; those appointed for the terrestrial, were almost on a level with the surface of the earth. On the contrary, they dug a hole for the altars of the infernal gods.

Before temples were in use, altars were erected sometimes in groves, sometimes in the highways, and sometimes on the tops of mountains; and it was a custom to engrave upon them the name, ensign, or character of the deity to whom they were consecrated.

In the great temples of ancient Rome, there were ordinarily three altars: The first was placed in the sanctuary, at the foot of the statue of the divinity, upon which incense was burnt, and libations offered; the second was before the gate of the temple, and upon it they sacrificed the victims; and the third was a portable altar, upon which were placed the offering and the sacred vessels.

Besides these uses of altars, the ancients swore upon them, and swore by them, in making alliances, confirming treaties of peace, and other solemn occasions. Altars also served as places of refuge to all those who fled to them, whatever crime they had committed.

Among the Jews, altars in the patriarchal times were very rude. The altar which Jacob set up at Bethel was nothing but a stone, which served him instead of a bolster; that of Gideon, a store before his house; and the first which God commanded Moses to erect was probably of earth, or unpolished stones, without any iron; for if any use was made of that metal, the altar was declared impure.

The principal altars of the Jews were those of *incense*, of burnt-offering, and the altar, or table, for the shew-bread.

The altar of incense was a small table of shittim-wood, covered with plates of gold, of one cubit in length, another in width, and two in height.

At the four corners, were four kinds of horns, and all round a little border or crown over it. This was the altar hidden by Jeremiah before the captivity; and upon it the officiating priest offered, every morning and evening, incense of a particular composition. See plate XI. fig. 2.

The altar of burnt-offerings was made of Shittim-wood, and carried upon the shoulders of the priests by staves of the same wood, overlaid with brass. In the time of Moses, this altar was five cubits square, and three high; but in Solomon's temple it was much larger, being twenty cubits square, and ten in height. It was covered with brass; and at each corner was a horn or spire wrought out of the same wood with the altar, to which the sacrifices were tied. Within the hollow was a grate of brass, on which the fire was made; through it fell the ashes, and were received in a pan below. At the four corners of the grate were four rings, and four chains, which kept it up at the horns. This altar was placed in the open air, that the smoke of the burnt-offerings might not füll the inside of the tabernacle. See plate XI. fig. 3.

The altar, or table for the shew-bread, was likewise of shittim-wood, covered with plates of gold; having a little border round it, adorned with sculpture. It was two cubits long, one wide, and one and an half in height. Upon this table, which stood in the holy of holies, were put, every sabbath day, twelve loaves, with salt and incense.

The Jewish altars, after the return from the captivity, and the building of the second temple, were in some respects different from those described above.

That of burnt-offerings was a large pile, built of unhewn stones, thirty-two cubits square at the bottom, and twenty-four square at the top. The ascent was by a gentle rising, thirty-two cubits in length, and sixteen in breadth.

**ALTAR** is also used among Christians for the communion-table. See **COMMUNION-TABLE**.

**ALTAR** is sometimes also used to denote the offerings made at the altar, in contradistinction from the settled revenues of a church.

**ALTAR**, in astronomy. See **ARA**.

**ALTAR-THANE**, in old law books, an appellation given to the priest or parson of a parish, to whom the altarge belonged. See **ALTARGE**.

**ALTARGE**, in law, altars erected in virtue of donations, before the Reformation, within a parochial church, for the purpose of singing of mass for deceased friends. See **SCOTS LAW**, title, *Ecclesiastical persons*. **ALTARGE** likewise signifies the profits arising to the priest on account of the altar.

**ALTARIST**, the same with altar-thane. See **ALTAR-THANE**.

**ALTEA**, a sea-port town of Spain, situated upon the Mediterranean, in the province of Valencia, about 45 miles south of the city Valencia, W. lon. 15'. N. lat. 38° 46'.

**ALTEMBURG**, a town of Transilvania, subject to the house of Austria, situated in 23° E. long. and 46° 25' N. lat.

**ALTEMBURG**,

**ALTEMBERG** is also used by some for Altenburg. See **ALTEMBERG**.

**ALTENA**, a port-town of Holstein, in Germany, situated on the river Elbe. It belongs to the Danes, and is the place where all their East India goods are sold.

**ALTENBURG**, a town of Misnia, in the upper Saxony, about 25 miles S. of Leipzig, and subject to the duke of Saxe Altenburg. E. long.  $12^{\circ} 44'$ , N. lat.  $50^{\circ} 52'$ .

**ALTENBURG-OWAR**, a fortified town of lower Hungary, situated on the river Danube, and subject to the house of Austria. E. long.  $17^{\circ} 20'$ , N. lat.  $48^{\circ} 15'$ .

**ALTENSPACH**, a city of Germany, in the circle of Swabia, situated between the lakes of Constance and Zeill.

**ALTERANTS**, or **ALTERATIVE medicines**, such as correct the bad qualities of the blood and other humours, without occasioning any sensible evacuation.

**ALTERATE**, in music and geometry. See **SESQUI**.

**ALTERATION**, in a general sense, denotes some variation in the qualities or circumstances of a thing, without wholly changing its nature.

**ALTERATION**, in medicine, is particularly used to denote the action of alterant medicines. See **ALTERANTS**.

**ALTERCUM**, in botany, an obsolete name of the Hyosciamus. See **HYOSCIAMUS**.

**ALTERDOCHAON**, a town of Portugal, in Estremadura, three leagues S. W. of Portalegre.

**ALTERITY**, a term used by some philosophers for what is more usually called diversity. See **DIVERSITY**.

**ALTERN-BASE**, in trigonometry, a term used in contradistinction to the true base. Thus in oblique triangles, the true base is either the sum of the sides, and then the difference of the sides is called the altern-base; or the true base is the difference of the sides, and then the sum of the sides is called the altern-base.

**ALTERNATE**, in a general sense, a term applied to such persons or things as succeed each other by turns. Thus, two who command each his day, are said to have an alternate command, or to command alternately.

**ALTERNATE**, in heraldry, is said in respect of the situation of the quarters.

Thus the first and fourth quarters, and the second and third, are usually of the same nature, and are called alternate quarters.

**ALTERNATE**, in botany, when the leaves or branches of plants arise higher on opposite sides alternately.

**ALTERNATE angles**. See **GEOMETRY**.

**ALTERNATE ratio**. See **ALGEBRA**, and **ARITHMETIC**.

**ALTERNATION**, properly signifies a succession by turns. See **ALTERNATE**.

**ALTHÆA**, in botany, a genus of the monadelphia polyandria class. The calix of the althæa is double, and the outer one is divided into nine segments; and the capsules are numerous, each containing but one seed.

There are three species of this genus, *viz.* the officinalis, a native of Britain, the root and leaves of which are supposed to be balsamic, pectoral and stomachic; the cannabina, a native of Hungary; and the hirsuta, a native of France, Italy, &c.

**ALTINGAR**, the name of a flux-powder, used in the fusion of metals. See **FLUX**, and **CHEMISTRY**.

**ALTIN**, a kingdom of Asia, in great Tartary, between the sources of the Irtych and the Oby. It is bounded on the north by the Kirgises, on the east by the Amaduners, on the south by the kingdom of Eluth, and on the west by the Irtych, which separates it from Barabinskoi.

**ALTIN**, is also the capital of the kingdom of that name, situated in the northern part of the kingdom, at the head of the river Kilam.

**ALTIN**, in commerce, a kind of money current in Moscow, worth three copics.

**ALTITH**. See **ASA-FOETIDA**.

**ALTITUDE**, accessible, and inaccessible. See **PRACTICAL GEOMETRY**.

**ALTITUDE**, of a figure, is the nearest distance of its vertex from its base, or the length of a perpendicular let fall from the vertex to the base.

**ALTITUDE** in optics, is the height of an object above a line, drawn parallel to the horizon from the eye of the observer.

**ALTITUDE of the eye**, in perspective, is its perpendicular height above the geometrical plane.

**ALTITUDE of a star**, &c. in astronomy, is an arch of a vertical circle, intercepted between the star and the horizon. See **ASTRONOMY**.

**ALTITUDE of motion**, according to Dr Wallis, is its measure estimated in the line of direction of the moving force.

**ALTITUDE**, in astrology. See **EXALTATION**.

**ALTITUDE of fluids**, is more usually expressed by the term depth. See **DEPTH**.

**Determinative ALTITUDE**, that from whence a heavy body falling, acquires a certain velocity by its natural acceleration.

**ALTKIRK**, a town of Alface in Germany, situated on the river Ill, in N. lat.  $47^{\circ} 40'$ , and E. lon.  $7^{\circ} 15'$ .

**ALTMORE**, a town of Ireland, in the county of Tyrone, and province of Ulster, situated in N. lat.  $54^{\circ} 34'$ , and W. long.  $7^{\circ} 2'$ .

**ALTMUL**, a river of Germany, which arising in Franconia, runs S. E. by the city of Anspach; and continuing its course E. by Pappenheim and Aichstet, falls into the Danube at Kelheim, about 12 miles above Ratibon.

**ALTO**, and **BASSO**, in law, denotes the absolute submission of all differences high and low to some arbitrator.

**ALTOM**, a name given, in several parts of the Turkish dominions, to what the Europeans call a sequin. See **SEQUIN**.

**ALTO-MONTE**, a town of the hither Calabria, in the kingdom of Naples, at the foot of the Apennines, ten miles from Cassano.

**ALTO-RELIEVO**. See **RELIEVO**.

**ALTO-**

- ALTO-RIPIENO**, in music, the tenor of the great chorus which sings and plays only now and then in some particular places.
- ALTORF**, a town of Germany, in the circle of Swabia, situated in N. lat.  $47^{\circ} 46'$ , and E. long.  $9^{\circ} 35'$ .
- ALTORF**, is likewise the name of a town in the circle of Franconia, situated in N. lat.  $49^{\circ} 20'$ , and E. long.  $11^{\circ} 20'$ .
- ALTORF**, is also the capital of the canton of Uri, in Switzerland, situated on the lake Lucern, in N. lat.  $46^{\circ} 50'$ , and E. long.  $8^{\circ} 30'$ .
- ALTRINGHAM**, a town of Cheshire in England, upon the borders of Lancashire, seven miles from Manchester.
- ALTRIP**, a small town of Germany, in the diocese of Spire, situated upon the Rhine, a little above Mannheim.
- ALTUMAL**, a term sometimes used to denote the mercantile style or dialect.
- ALTUS**, in music. See COUNTER-TENOR.
- ALTZHEIM**, or **ALTZEY**, a town of Germany, situated in N. lat.  $49^{\circ} 45'$ , and E. long.  $7^{\circ} 52'$ , about 42 miles N. W. of Heidelberg.
- ALVA de Tormes**, a town of Spain, in the province of Leon, situated on the river Tormes, in N. lat.  $41^{\circ}$ , and W. long.  $6^{\circ}$ , about 16 miles S. E. of Salamanca.
- ALVAH**, among the Mahometans, the name by which they call the wood wherewith Moses sweetened the waters of Marah.
- ALVAHAT**, a province of higher Egypt, situated under the tropics.
- ALVARID**, in the history of Spain, a kind of magistrate or judge, differing very little from the alcaid. See ALCAID.
- ALVARISTS**, in church history, a branch of Thomists, so called from Alvarez their leader; who asserted sufficient grace, instead of the efficacious grace of the ancient Thomists. See THOMISTS.
- ALUCO**, in ornithology, the trivial name of a species of strix. See STRIX.
- ALUDE**, a kind of sheep's leather, one side of which has the wool on.
- ALUDELS**, in chemistry, earthen pots ranged one above another, for retaining the flowers which ascend in the process of sublimation. The lowest aludel is fitted to the pot which contains the matter to be sublimed, and at the top is a close head for collecting the flowers which ascend highest. See CHEMISTRY.
- ALVEARIUM**, in anatomy, the hollow of the outer ear. See ANATOMY, Part VI.
- ALVEARIUM**, in matters of literature, is used in a figurative sense for a collection or thesaurus.
- ALVEOLUS**, in natural history, the name of the waxen cells in bee-hives. See APIS.
- ALVEOLUS**, in anatomy, the sockets in the jaws wherein the teeth are fixed. See ANATOMY, Part I.
- ALVEOLUS**, in botany, the name of the cells in which the seeds of several plants are ranged.
- ALVEOLUS**, in natural history, a sea fossilife of a conic figure, composed of a number of cells, like bee-hives, joined into each other, with a pipe of communication.
- ALVEUS**, in anatomy, a name sometimes given to the tumid lacteal vessels proceeding from the receptaculum chyli.
- ALVEUS**, is also used in Roman antiquity, for a kind of boat, fashioned out of the trunk of a single tree: Such was that in which Romulus and Remus were exposed.
- ALVIDONA**, a town of Calabria, in the kingdom of Naples, upon the gulph of Rossano.
- ALVI fluxus**, among physicians. See DIARRHOEA.
- Obstradio ALVI**, a Latin phrase for costiveness. See COSTIVENESS.
- ALVIDUCA**, among physicians, a term for laxative medicines.
- ALUM**, or **ALUMEN**, in natural history, a peculiar kind of salt, sometimes found pure, but oftner separated from several substances, as a soft reddish stone in Italy, several kinds of earth, and, in England, from a whitish or bluish stone, called Irish slate. Alum, in medicine, is a powerful astringent. In dying, it fixes the colours upon the stuff. See CHEMISTRY.
- Process of making ALUM.* At Whitby, in Yorkshire, alum is made thus: Having burnt a quantity of the ore with whins, or wood, till it becomes white, then they barrow it in a pit, where it is steeped in water for eight or ten hours. This liquor, or lixivium, is conveyed by troughs to the alum-house, into cisterns, and from them into the pans, where it is boiled about 24 hours. They add a certain quantity of the lee of kelp; the whole is drawn off into a settler; where having remained about an hour, that the sulphur and other dregs may have time to settle to the bottom, it is conveyed into coolers. This done, to every tun of the liquor they add about eight gallons of urine; and having stood four days and nights, till quite cool, the alum begins to crystallize on the sides of the vessel, from which being scraped off, it is washed with fair water, and then thrown in a bing, to let the water drain off. After this it is thrown into a pan, called the roching pan, and there melted; in which state it is conveyed by troughs into tuns, where it stands about 10 days, till perfectly condensed. Then staving the tuns, the alum is taken out, chipped, and carried to the store-houses.
- This is what we commonly call roche or rock alum, as being prepared from stones cut from the rocks of the quarry; and stands contradistinguished from the common alum, or that prepared from earths.
- Artificial ALUM*, that prepared by art, in contradistinction from the native alum. It is also used for alum produced by causing burnt earthen vessels imbibe a large quantity of oil of vitriol; the effect of which is, that they are thereby reduced to a mucilage, which, being exposed to the open air, affords crystals of pure alum. Tobacco-pipes, wetted with spirit of sulphur, likewise afford beautiful crystals of plumose alum.
- Burnt ALUM*, is that melted in a fire-shovel, or crucible, where it is allowed to bubble till it becomes a white hard substance.
- The watery part of the alum being thus expelled,

- the remainder is left possessed of all its acids, less clogged, and more in a condition to exert its effects. It proves a gentle escharotic, and is used in small quantities, mixed with other ingredients, in tooth-powders.
- Crude ALUM**, that which has undergone no other refinement than what it receives at the alum-works.
- Native ALUM**, or *Fossil ALUM*, that formed by nature, without the assistance of art.
- There are still mines of native alum in the island of Chio, consisting of a kind of vaults, or apartments crusted over with alum, which may be looked upon as exfoliations from the rock.
- Plumose ALUM**, or *Plume ALUM*, a kind of natural alum, composed of a sort of threads, or fibres, resembling feathers; whence it has its name.
- Prepared ALUM**, or *Purified ALUM*, that which is dissolved in hot rain-water, and afterwards made to crystallize, by evaporating the water.
- Roche-ALUM**, or *Rock-ALUM*. See the article, *Process of making ALUM, supra*.
- Roman ALUM**, a sort of rock-alum, of a reddish colour, made in the country near Rome.
- Saccharine ALUM**, is a composition of common alum with rose-water, and the whites of eggs, which being boiled to the consistence of a paste, is formed in the shape of a sugar-loaf; it is used as a cosmetic.
- Scissile ALUM**, the same with plumose alum.
- ALUMEN**, the Latin name of alum.
- ALUMEN catini**, a name sometimes used for the salt of the kali.
- ALUMEN scagliola**, a name sometimes used for *lapis specularis*.
- ALUMINOUS**, an epithet for things that partake of the nature of alum.
- ALUMTA**, in botany. See *LUTROLA*.
- ALUS**, or *ALUM*, in botany, an obsolete name of the symphytum. See *SYMPHYTUM*.
- ALVUS**, in anatomy, a term used for the belly in general, but more frequently applied to the bowels.
- ALWAIIDII**, a sect of Mahometans who believe all great crimes to be unpardonable.
- ALYPIAS**, the name of a kind of white turbith. See *TURBITH*.
- ALPUM**, in botany, a synonyme and likewise the trivial name of a species of globularia. See *GLOBULARIA*.
- ALYSSOIDES**, in botany, a synonyme of the alyssum. See *ALYSSUM*.
- ALYSSUM**, or *ALYSSON*, in botany, a genus of the tetradynamia filiculosa. The flowers of the alyssum consist of four leaves in the form of a cross: The capsule is short and smooth, and contains a number of roundish seeds. There are 14 species of the alyssum, none of which are natives of Britain.
- ALYTARCHA**, a priest of Antioch in Syria, who, in the games instituted in honour of the gods, presided over the officers who carried rods to clear away the crowd, and keep order.
- In the Olympic games, the alytarches had the same
- constand, and obliged every person to preserve order and decency.
- ALZACHI**, in botany, an obsolete name of the anguria. See *ANGURIA*.
- ALZAGI**, or *ALZROI*. See *ZROI*.
- ALZARAC**, the Arabian name of a coarse kind of castor.
- ALZIRA**, a town of Spain, in the province of Valencia, situated on the river Xucar, about 18 miles S. of the city of Valencia, W. long. 20°, N. lat. 39° 10'.
- ALZIZ**, among Arabian physicians. See *ZIZ*.
- ALZUM**. See *BDELLIUM*.
- AMA**, among ecclesiastical writers, denotes a vessel in which wine or water were kept for the service of the eucharist.
- AMA**, is sometimes also used for a wine-measure, as a pipe, or the like.
- AMABYR**, or *AMVABYR*, a custom which formerly prevailed in Wales, and some other parts of the kingdom; being a certain fine, or sum of money, paid to the lord upon marrying a maid within his manor.
- AMACACHES**, a people of Brazil, in S. America, near the government of Rio Janeiro.
- AMACUSA**, an island of Japan, separated by a narrow strait from Saiooco, or Ximo.
- AMACUSA**, is also the capital of the province of that name.
- AMACAO**. See *MACOA*.
- AMADABAT**, a large populous trading city in the E. Indies, the capital of the province of Guzarat, or Cambay, and situated in 72° E. long. and 23° 40' N. lat.
- AMADAN**, or *HAMADAN*, in geography. See *HAMADAN*.
- AMADANAGER**, a town in the higher peninsula of India, situated in 74° 15' E. long. and 18° N. lat.
- AMADIA**, a city of Asiatic Turkey, in the province of Curdestan, situated on a high mountain, in 43° E. long. and 37° N. lat.
- AMAIN**, or *AMAYNE*, in the sea-language, a term importing to lower something at once. Thus, to strike amain, is to lower, or let fall, the top-sails; to wave amain, is to make a signal, by waving a drawn sword, or the like, as a demand that the enemy strike their top-sails.
- AMAK**, or *AMAKA*, an island of Denmark, lying in 13° 5' E. long. and 55° 29' N. lat. and separated by a very narrow channel from Copenhagen.
- AMALFA**, a city of Italy, in the kingdom of Naples, and province of the hither Principato. It is the see of an archbishop, and remarkable for giving birth to Flavius Blendus, inventor of the seaman's compass. E. long. 15° 20', N. lat. 48° 50'.
- AMALGAM**, mercury united with some metal. See *CHEMISTRY*.
- AMALGAMATION**, in chemistry, the operation of making an amalgam, or mixing mercury with any metal. See *CHEMISTRY*.
- AMALGAMATION**, is also used by some, in a less proper sense, for a solution of sulphur with mercury.

AMAN,



- AMAZZ**, a port of Africa, in the kingdom of Morocco, upon the Atlantic ocean, between cape Ger, and cape Cantin.
- AMAU**, is also the name of a kingdom, near the middle of the island of Sumatra, in the E. Indies.
- AMANCE**, a town of Lorrain, situated in  $6^{\circ} 10'$  E. long. and  $48^{\circ} 40'$  N. lat. about seven miles N. E. of Nancy.
- AMAND**, or **St AMAND**, the name of two towns, one situated in the duchy of Bourbon, in the province of Lyonnois in France; and the other in French Flanders, about six miles N. of Valenciennes.
- AMANTEA**, a sea-port town and bishop's see of the kingdom of Naples, situated near the bay of Euphemia, in the province of Calabria, in  $16^{\circ} 20'$  E. long. and  $39^{\circ} 15'$  N. lat.
- AMAPALLA**, a sea-port town of Mexico, in the province of Guatemala, situated on the Pacific ocean, in  $93^{\circ}$  W. long. and  $12^{\circ} 30'$  N. lat.
- AMARACUS**, in botany, a synonyme of the origanum. See **ORIGANUM**.
- AMARANTA**, or **AMARANTE**, an order of knighthood, instituted in 1653, by Christina Queen of Sweden, in memory of a masquerade, wherein she had assumed that name, which signifies *unfading*, or *immortal*. Her nobility likewise assumed different characters, viz. of gods, goddesses, shepherds, nymphs, &c. and so well pleased was the Queen with the diversion, that she instituted this order in memory of it, consisting of 16 lords, and as many ladies, with the motto, *Dolce nella memoria*.
- AMARANTH**, in botany. See **AMARANTHUS**.
- AMARANTHOIDES**, in botany, the trivial name of a species of illecebrium. See **ILLECEBRUM**.
- AMARANTHUS**, in botany, a genus of the monœcia pentandria class. The flowers have no petals; the calix is multiseid; and the seeds are contained in membranaceous vessels, and very numerous. There are 22 species of amaranthus, none of them natives of Britain, except the blitum, or lesser blite; all the others are found in the Indies. The amaranthus is said to be astringent.
- AMARYLLIS**, in botany, a genus of the hexandria monogynia class. The spathe of the amaryllis consists of one leaf, the flower, like other liliaceous plants, has six petals, and the stigma is trifid. There are 12 species of the amaryllis, all of them natives of the warm climates. Fig. 1. of plate XII. represents the orientalis, a native of the E. Indies.
- AMASIA**, the northern division of lesser Asia, lying on the S. shore of the Euxine sea.
- AMASIA**, is also the name of the capital city of the above province, situated in  $36^{\circ}$  E. long. and  $42^{\circ}$  N. lat. about 70 miles S. of the Euxine sea.
- AMASTRIS**, or **AMASTRO**, a city of Turkey in Asia, in the province of Bressangil, situated on the Black Sea.
- AMATIDES**, a name used by some for an incombustible stone. See **AMIANTHUS**.
- AMATTLAN**, a town of N. America, situated in the valley of Mixco, in the province of Guatemala.
- AMATORII muscoli**, in anatomy, a term sometimes used for the obliquus superior and obliquus inferior muscles of the eye; as these muscles assist in ogling or drawing the eye sideways. See **ANATOMY**, part VI.
- AMATRICE**, a city of the kingdom of Naples, in the farther Abruzzo, upon the confines of the pope's territories, and the marquisate of Ancona.
- AMAUROSIS**, in medicine, a distemper in the eye, occasioned by an insensibility of the retina. See **MEDICINE**.
- AMAUSA**, a term used by chemists for pastes counterfeiting gems.
- AMAXOBII**, the same with *hamaxobii*.
- AMAZON**, in a general sense, denotes a bold daring woman.
- AMAZONS**, were an ancient nation of women, inhabiting that part of lesser Asia now called Amasia. See **AMASIA**.
- The Amazons are said to have killed all their male children, and to have cut off the right breasts of their females, to fit them for martial exercises. The existence, however, of such a nation is controverted by many judicious authors, and defended by others, particularly Mr Petit, who has published a dissertation on the subject, wherein are several curious inquiries concerning their arms, dress, &c.
- We also read of Scythian Amazons, of German Amazons, of Lybian Amazons, and Amazons of America, living on the banks of the great river which bears their name, who are represented as governed by a queen, no man being permitted to live among them; only, at a certain season, those of the neighbouring nations are suffered to visit them for the sake of procreation. The Amazons of Lybia are famous for their wars with another female nation called Gorgons. See **GORGONS**.
- On medals, the bust of the Amazons is ordinarily represented armed with a little battle-ax, called by the Romans *biceps*, or *securis*, which they carried on their shoulder with a small buckler, in form of a half moon, distinguished by the name of *pelta*, upon their left arm.
- AMAZONS**, in a figurative sense, an appellation given to bees, as being governed by a queen.
- AMAZON**, in geography, a great river in S. America, which rising in Peru, near the equator, runs eastward a course of more than 3000 miles; and, like other rivers between the tropics, annually overflows its banks, at which season it is about 150 miles broad where it falls into the ocean.
- AMAZONIAN**, denotes something belonging to the amazons.
- AMBACHT**, a term used in some parts of Germany and Flanders, for the magistracy of a city, or the district or territory belonging to it.
- AMBADAR**, a city of Africa, in the upper Ethiopia, situated upon the Nile, between the provinces of Darnbea and Savea.
- AMBAGES**. See **CIRCUMLOCUTION**.
- AMBAMARJAM**, or **AMBARA**, the capital city of Abyssinia,

Abyssinia, or higher Ethiopia, situated on the side of a lake, out of which the river Nile issues; 35° E. long. and 13° S. lat.

**AMBARVALIA**, in antiquity, a ceremony among the Romans, when, in order to procure from the gods an happy harvest, they conducted the victims thrice round the corn-fields in procession, before sacrificing them. *Ambarvalia* were either of a private or public nature: the private were performed by the master of a family; and the public by the priests who officiated at the solemnity, called *fratres arvales*. The prayer preferred on this occasion, the formula of which we have in Cato, de Re Rust. cap. cxlii. was called *carmen ambarvale*.

At these feasts they sacrificed to Ceres a sow, a sheep, and a bull, or heifer, whence they take the name of *suovetaurilia*.

The method of celebrating them, was to lead a victim round the fields, while the peasants accompanied it, and one of their number, crowned with oak, hymned forth the praises of Ceres, in verses composed for purpose.

This festival was celebrated twice a-year, at the end of January, according to some, or in April, according to others; and for the second time in the month of July.

**AMBARVALIS**, in botany, an obsolete name of the polygala. See **POLYGALA**.

**AMBE**, in surgery, an instrument for reducing dislocated bones.

**AMBE**, in anatomy, a term for the superficial jutting out of a bone.

**AMBER**, *succinum*, or *electrum*, in natural-history, a hard bituminous inflammable substance, brittle, somewhat transparent, generally of a yellowish colour, and when warm sends forth a fragrant bituminous odour. Amber is likewise endowed with an electrical virtue; when rubbed, it attracts straws or other light bodies. The taste of amber is acrid, bituminous, and somewhat astringent. It does not effervesce with acids, and is soluble in spirit of wine and essential oils. When subjected to a chemical analysis, it first yields a subacid water, afterwards a yellow fetid oil, and a volatile salt; what remains in the retort, is a black, light, friable matter, resembling the *bitumen Judaicum*.

Amber is chiefly found in Prussia, and in the Baltic sea, near the shore of Sudavia, where it is found swimming on the surface of the water, and is taken in nets. It is esteemed a powerful medicine in hysteric and hypochondriac cases.—Naturalists are much divided about the origin of amber: Some maintaining it to be an animal substance, others a resinous juice oozing from poplars and firs near the shore, and running into the sea. - But it has lately been found to be a true bitumen; the veins of which were discovered, by the Prussians, in the bowels of the earth, in the marsh near Kustrin.

**AMBERG**, in geography, a river, which rising in the S. W. part of Bavaria, runs N. E. by Lansperg and Dachan, and falls into Iser, a little above Landshut:

**AMBERG**, a fortified town of Bavaria, situated on the river IIs, about 30 miles N. of Ratibon, in 52° E. long. and 49° 25' N. lat.

**AMBERGREASE**, or **AMBERGRISE**, in natural history, is a solid, opaque, ash-coloured, fat, inflammable substance, variegated like marble, remarkably light, rugged and uneven in its surface, and has a fragrant odour when heated. It does not effervesce with acids; melts freely over a fire, into a kind of yellow rosin, and is hardly soluble in spirit of wine. Ambergrise is greatly used by perfumers on account of its sweet smell. In medicine it is used for nervous complaints. It is found in great quantities in the Indian ocean, near the Molucca isles, as also near Africa, and sometimes near the northern parts of England, Scotland, and Norway. There has been many different hypotheses concerning the origin of ambergrease, but the most probable is that which supposes it to be a fossil: bitumen, or naphtha, exuding out of the bowels of the earth, in a fluid form, and distilling into the sea, where it hardens, and floats on the surface.

**AMBERING**, a term used by some writers for giving the scent of amber to any thing.

**AMBERT**, a city of France, in the lower Auvergne, remarkable for its manufactures in paper and camblots.

**AMBETTUWAY**, in botany, a barbarous name of a tree, the leaves of which, when boiled in wine, are said to create an appetite, and is used by the people in Guinea with that intention.

**AMBIAM**, a kingdom of Ethiopia, situated between the Nile, and a river which rises out of the lake Zaffan.

**AMBIDEXTER**, a person who can use both hands with the same facility and for the same purposes that the generality of people do their right hands.

**AMBIEGNÆ oves**, in the heathen sacrifices, an appellation given to such ewes as, having brought forth twins, were sacrificed together with their two lambs, one on each side. We find them mentioned among other sacrifices to Juno.

**AMBIENT**, a term used for such bodies, especially fluids, as encompass others on all sides: thus, the air is frequently called an ambient fluid, because it is diffused round the earth.

**AMBIERLE**, a city of France, three leagues from Rouanne, and 15 from Lyons, on the borders of the Lionnois.

**AMBIGENAL hyperbola**, a name given by Sir Isaac Newton to one of the triple hyperbolas of the second order, having one of its infinite legs falling within an angle formed by the asymptotes, and the other without.

**AMBIGUITY**, in rhetoric and grammar, a defect of language, whereby words are rendered ambiguous. See the next article.

**AMBIGUOUS**, a term applied to a word or expression which may be taken in different senses.

**AMBILLON**, a village of France, in Touraine, where there is a great quarry for mill-stones.

**AMBIT**, in geometry, is the same with what is otherwise

- wife called the perimeter of a figure. See PERIMETER.
- AMBITUS**, in Roman antiquity, the setting up for some magistracy or office, and formally going round the city to solicit the interest and votes of the people. On these occasions, it was not only usual to solicit the interest of their friends and others with whom they were personally acquainted, but the candidates, being attended by persons of an extensive acquaintance, who suggested to them the names of the citizens, and thence called *nomenclatores*, or *interpretes*, made their application to all they met. This method of suing for offices was deemed allowable, and therefore never prohibited by law; but to restrain all undue influence, whether by bribery, or exhibiting games, shews, and the like, many laws were enacted, and severe fines imposed.
- AMBLE**, in horsemanship, a peculiar pace by which a horse's two legs of the same side move at the same time.
- AMBLETEUSE**, a small sea-port-town of Picardy in France, situated about five miles north of Boulogne.
- AMBLYGON**, in geometry, denotes an obtuse angled triangle, or a triangle one of whose angles consists of more than ninety degrees.
- AMBLYOPY**. See *GUTTA SERENA*.
- AMBO**, or **AMBON**, in ecclesiastical antiquity, a kind of pulpit or reading-desk, where that part of the divine service called the gradual was performed.
- AMBOHETSMENES**, a province in the island of Madagascar, near the mountains of the same name.
- AMBONUM**. See *OCULUS BELI*.
- AMBOINA**. See *AMBOYNA*.
- AMBOISE**, a town of Orleansois, in France, situated on the river Loire, about ten miles east of Tours, in  $1^{\circ}$  E. long. and  $47^{\circ} 25'$  N. lat.
- AMBOYNA**, an island of the E. Indies, lying between the Molucca isles and those of Banda, in  $126^{\circ}$  E. long. and  $3^{\circ} 40'$  S. lat.
- In this island, which is about seventy miles in circumference, the Dutch have a strong fort, garrisoned by seven or eight hundred men. What makes it the more remarkable, is the cruel usage and expulsion of the English factors by the Dutch, in the reign of K. James I.
- AMBOSINE**, a province of Africa, in the kingdom of Benin.
- AMBOTE**, a town of Poland, in Samogitia, upon the river Wardaria, two Polish miles from Siade, and nine from the Baltic sea.
- AMBOULE**, a large country in the island of Madagascar, to the north of Carcanossi.
- AMBOULE** is also the name of a considerable village in that country.
- AMBOURNAY**, a small town of France, upon the river Ain, on the road from Lyons to Geneva.
- AMBRA**, or **AMBRAGRISIA**. See *AMBERGREEN*.
- AMBRASI**, a river of Africa, which, after washing the kingdom of Congo, falls into the Ethiopian Ocean.
- AMBRES**, a city of France, in the Upper Languedoc, in the diocese of Castres.
- AMBRESBERRY**, a market-town in Wiltshire, about six miles north of Salisbury, and situated in  $1^{\circ} 40'$  W. long. and  $51^{\circ} 20'$  N. lat.
- AMBROSE**, or *St AMBROSE in the wood*, an order of religious, who use the Ambrosian office, and wear an image of that saint engraven on a little plate: in other respects they conform to the rule of the Augustins. See *AMBROSIAN OFFICE*, and *AUGUSTINS*.
- AMBROSIA**, in heathen antiquity, denotes the solid food of the gods, in contradistinction from the drink, which was called *nectar*. It had the appellation *ambrosia*, as being supposed to render those immortal who fed thereon.
- AMBROSIA**, is also a term for rough or crude wax, supposed to be the food of bees.
- AMBROSIA**, in Grecian antiquity, a name sometimes used for a festival of Bacchus, otherwise called *lenæa*. See *LENÆA*.
- AMBROSIA**, in botany, a genus of the monœcia pentandria class. The male floscules of the ambrosia have no petals; the fruit of the female is prickly, and shaped like a club, containing one oblong seed in each. There are four species of ambrosia, *viz.* the *trifida*, *elatior*, and the *artemisifolia*, all natives of America; and the *maritima*, a native of Greece.
- AMBROSIAN office**, in church-history, a particular formula of worship in the church of Milan, which takes its name from St Ambrose, who instituted that office in the fourth century. Each church originally had its particular office; and when the pope, in after-times, took upon him to impose the Roman office upon all the western churches, that of Milan sheltered itself under the name and authority of St Ambrose; from which time the Ambrosian ritual has prevailed.
- AMBROSIN**, a coin formerly struck by the dukes of Milan, representing St Ambrose on horseback, with a whip in his right hand.
- AMBRUN**, in geography, the same with Embrun. See *EMBRUN*.
- AMBRÏ**, a place in which are deposited all utensils necessary for house-keeping. In the ancient abbeys and priories, there was an office under this denomination, wherein were laid up all charities for the poor.
- AMBUBAJÆ**, in Roman antiquity, were immodest women, who came from Syria to Rome, where they lived by prostitution, and by playing on the flute.
- AMBUBEJA**, in botany, an obsolete name of the *cichorium*. See *CICHORIUM*.
- AMBUILA**, or **AMBOILA**, a country of Africa, in the kingdom of Congo, between the lake Aqueponde and St Salvador.
- AMBULATION**. See *WALKING*.
- AMBULATION**, in surgery, a term used for the spreading of a gangrene or mortification.
- AMBULATORY**, a term applied to such courts as were not fixed, but removed sometimes to one place, sometimes to another.
- AMBURBIUM**, in Roman antiquity, a procession made by the Romans round the city and pomerium, in which

- they led a victim, and afterwards sacrificed it, in order to avert some calamity that threatened the city.
- AMBURY**, or **ANBURY**, among farriers, denotes a tumor, wart, or swelling, which is soft to the touch, and full of blood.
- This disorder of horses is cured by tying a horse-hair very hard about its root, and, when it has fallen off, which commonly happens in about eight days, strewing some powder of verdegriis upon the part, to prevent the return of the complaint. If the tumor be so low that nothing can be tied about it, they cut it out with a knife, or else burn it off with a sharp hot iron; and, in sinewy parts, where a hot iron is improper, they eat it away with oil of vitriol, or white sublimate.
- AMBUSCADE**, or **AMBUSH**, in the military art, properly denotes a place where soldiers may lie concealed, till they find an opportunity to surprize the enemy.
- AMBUSTION**, with physicians, the same with a burn.
- AMBY**, a town of the Austrian Netherlands, in the province of Limburg, situated opposite to Maestricht, on the east-side of the river Maese, in  $5^{\circ} 45'$  E. long. and  $50^{\circ} 56'$  N. lat.
- AMED**, or **AMIDA**, a city of Asia in Mesopotamia: the Arabians call it Diarbeker, and the Turks Kara-Amed.
- AMEDEWAT**. See **AMADABAT**.
- AMEDIAN**S, in church-history, a congregation of religious in Italy, so called from their professing themselves *amantes Deum*, lovers of God; or rather, *amati Deo*, beloved of God.
- AMEIVA**, in zoology, the trivial name of a species of lacerta. See **LACERTA**.
- AMEL**, a term frequently used by Mr Boyle, in a synonymous sense with enamel. See **ENAMEL**.
- AMELAND**, an island of the United Provinces, in the German Ocean, near the coast of Friezland, from which it is separated by a straight called the Wadt.
- AMELBURG**, in geography, the same with Ommenburg. See **OMMENBURG**.
- AMELIA**, a city of Italy, situated on a mountain about fifty miles N. E. of Rome, in  $13^{\circ} 20'$  E. long. and  $42^{\circ} 40'$  N. lat.
- AMELLUS**, in botany, a genus of the syngenesia polygamia superflua class. The receptacle of the amellus is paleaceous; the calix is squarrous; and the rays of the corollula undivided. There are only two species of this genus, *viz.* the lychnitis, a native of the Cape; and the umbellatus, a native of Jamaica.
- AMEN**, in the scripture-language, a solemn formula or conclusion to all prayers, signifying, *So be it*.
- AMEND**, or **AMENDE**, in the French customs, a pecuniary punishment imposed by a judge for any crime, false prosecution, or groundless appeal.
- AMENDE honorable**, an infamous kind of punishment inflicted in France upon traitors, parricides, or sacrilegious persons, in the following manner: The offender being delivered into the hands of the hangman, his shirt is stripped off, and a rope put about his neck, and a taper in his hand; then he is led into court, where he must beg pardon of God, the king, the court, and his country. Sometimes the punishment ends here; but sometimes it is only a prelude to death, or banishment to the gallees.
- AMENDE honorable** is a term also used for making recantation in open court, or in presence of the person injured.
- AMENDOLARA**, a city of the kingdom of Naples, in the Hither Calabria.
- AMENDMENT**, in a general sense, denotes some alteration or change made in a thing for the better.
- AMENDMENT**, in law, the correction of an error committed in a process, which may be amended after judgment, unless the error lies in giving judgment, for in that case it is not amendable, but the party must bring a writ of error.
- A bill may be amended on the file at any time before the plea is pleaded; but not afterwards, without motion and leave of the court.
- AMENDMENT of a bill**, in parliament, is some alteration made in the first draught of it.
- AMENTACEOUS**, in botany, an epithet applied to such plants as are furnished with an amentum. See **AMENTUM**.
- AMENTUM**, in botany, the name of a species of calix, consisting of valves, and hanging down in different directions from the caulis. Common oats afford a good example of the amentum.
- AMENTUM**, in Roman antiquity, a thong tied about the middle of a javelin or dart, and fastened to the forefinger, in order to recover the weapon as soon as it was discharged. The ancients made great use of the amentum, thinking it helped to enforce the blow. It also denotes a latchet that bound their sandals.
- AMERADE**, the same with emir. See **EMIR**.
- AMERCEMENT**, or **AMERCIAMENT**, in law, a pecuniary punishment imposed upon offenders at the mercy of the court.
- AMERGO**, or **MARAGO**, a city of Africa, in the kingdom of Fez, three leagues from Beni-Tadi.
- AMERIA**, in geography. See **AMELIA**.
- AMERICA**, one of the four parts of the world, and by much the largest, extending near 9000 miles in length, and about 3000 in breadth. It is situated between  $35^{\circ}$  and  $145^{\circ}$  of W. long. and between  $58^{\circ}$  S. and  $80^{\circ}$  N. lat.; bounded by the lands and seas about the arctic pole on the north; by the Atlantic Ocean, which divides it from Europe and Africa on the west; by the vast Southern Ocean on the south; and by the vast Pacific Ocean, which divides it from Asia on the east. Although it is said to have taken its name from Americus Vesputius, a Florentine, it seems indisputable that it was first discovered by Christopher Columbus, a Genoese, *anno* 1491; unless some conjectures, much more ancient, be admitted, that it was first visited by a Carthaginian fleet, who afterwards settled in Mexico. It is certain, that its productions, whether animal or vegetable, differ greatly from those of any other country; and its original inhabitants, the Eskimaux only excepted, seem to have all the same original, for they agree in every particular, from Hudson's Bay, to the Straits of Magellan, excepting only where difference

difference of circumstances may make some dissimilarity. They have all originally a red copper colour, and every part of their bodies without hair, except the head, where it is black, straight, and coarse. In the Spanish and Portuguese settlements, gold is found in great plenty. Its remarkable rivers are, St Lawrence and the Mississippi, in N. America; and the Amazons and Rio de la Plata in S. America. The Andes, which bound Chili on the east, are the highest mountains in the world.

**AMERICIMA**, in zoology, an obsolete name of a species of lacerta. See **LACERTA**.

**AMERSFORT**, a town of the Dutch Netherlands, in the province of Utrecht, situated on the river Ems, about fourteen miles north-east of Utrecht, in  $5^{\circ} 20'$  E. long. and  $52^{\circ} 25'$  N. lat.

**AMERSHAM**, a market-town of Buckinghamshire, about twenty-seven miles westward of London. It is situated in  $40'$  W. long. and  $51^{\circ} 40'$  N. lat. and sends two members to parliament.

**AMETHYSTUS**, amethyst, a transparent gem of a purple colour, arising from a mixture of red and blue. However, their colour is various: Some have a mixture of yellow, and some resemble red wine and water; but the best kind is transparent and colourless, and resembling so much the diamond, that the difference can only be distinguished by the softness of the amethyst. This gem is found of various sizes, from the bulk of a small vetch, to an inch and an half in diameter. Its shape is sometimes roundish, sometimes oblong, and sometimes flattened a little on one side; but its most common figure is that of a crystal, composed of four planes, and terminated by a flat short pyramid. The amethyst is found in India, Arabia, Armenia, Ethiopia, Cyprus, Germany, Bohemia, and Misena; but as they are generally as soft as crystal, they are not much valued. It may be counterfeited many ways; but the Germans hardly think it worth the counterfeiting.

**AMETHYST**, in heraldry, a term for the purple colour in the coat of a nobleman, in use with those who blazon by precious stones, instead of metals and colours. This, in a gentleman's escutcheon, is called *Purple*, and in those of sovereign princes, *Mercury*.

**AMETHYSTEA**, in botany, a genus of the diandria monogynia class, of which there is but one species, viz. the *cærulea*, a native of the mountains of Siberia. The corolla of this plant is quinquefide, the calix a little bell-shaped, and the capsule contains four gibbous seeds.

**AMETHYSTINE**, in a general sense, an appellation given to whatever partakes of the nature, or emulates the colour of the amethyst.

**AMEY**, a city of Savoy, situated in a plain, upon the lake Nicv.

**AMGAILA**, or **AMGAILAM**, an obsolete name of a species of acanthus. See **ACANTHUS**.

**AMHAR**, or **AMHARA**, a kingdom of Abyssinia in Africa, subject to the great Negus. It is bounded on the north by the kingdom of Bajemder; on the east, by that of Angote; on the south, by the kingdom of

Walaca; and on the west, by the Nile, which separates it from the kingdom of Gojam. This country is remarkable for the mountains Ghefghen and Ambacel, where the children and near relations of the kings of Abyssinia were formerly confined; upon which account it is regarded as the native country of the modern emperors.

**AMIA**, in ichthyology, the trivial name of a species of schomber. See **SCHOMBER**.

**AMIANTHUS**, or earth-lax, in natural history, a fibrous, flexible, elastic mineral substance, consisting of short, abrupt, and interwoven filaments. It is found in Germany, in the strata of iron ore, sometimes forming veins of an inch in diameter. There is another kind of amianthus, which is to be met with in the marble quarries of Wales. But this kind Linnæus affirms to be an asbestos. The amianthus does not give fire with steel, nor ferment with acids. It endures an intense heat without injury to its texture.

**AMICABLE**, in a general sense, denotes any thing done in a friendly manner, or to promote peace.

**AMICABLE benches**, in Roman antiquity, were, according to Pitiscus, lower and less honourable seats allotted for the *judices pedanei*, or inferior judges, who, upon being admitted of the emperor's council, were dignified by him with the title *amici*.

**AMICITIA**, or *tenure in AMICITIA*, *tenere in amicitiam*, in the feudal customs, were lands granted freely to be enjoyed only so long as the donor pleased.

**AMICTUS**, in Roman antiquity, was any upper garment worn over the tunica.

**AMICTUS**, among ecclesiastical writers, the uppermost garment anciently worn by the clergy; the other five being the alba, singulum, stola, manipulus, and planeta.

The amictus was a linen garment, of a square figure, covering the head, neck, and shoulders, and buckled or clasped before the breast. It is still worn by the religious abroad.

**AMICULUM**, in Roman antiquity, a woman's upper garment, which differed from the pala. It was worn both by matrons and courtezans.

**AMICUS curia**, a law-term, to denote a by-stander who informs the court of a matter in law that is doubtful or mistaken.

**AMIENS**, the capital city of Picardy, in France, situated on the river Somme, in E. long.  $2^{\circ} 30'$ , and N. lat.  $49^{\circ} 50'$ . It is a beautiful town, and a bishop's see, under the archbishop of Rheims. Here too is an university of considerable note.

**AMIGDALUS**, in botany. See **AMYGDALUS**.

**AMIESTIES**, cotton cloths, which come from the E. Indies.

**AMILICTI**, in the ancient Chaldean theology, one of the triads of persons in the third order of the divine hierarchy. See **HIERARCHY**.

**AMINA**, a city of Ethiopia in Africa, nine miles from Albar.

**AMINEUM cetum**, the name of a vinegar made of the wine of Aminæ, a town of Campania in Italy.

**AMIRANTE**, in the Spanish polity, a great officer of state, answering to our lord high-admiral.

**AMISIA**,

**AMISIA**, or **AMISSA**, in geography. See **AMASIA**.  
**AMISS**, or *drawing* **AMISS**, among sportsmen. See **DRAWING**.  
**AMISSA**, or *lex amissa*. See **LEX**.  
**AMITTERE** *legem terræ*, among lawyers, a phrase importing the loss of liberty of swearing in any court.  
**AMMA**, in surgery. See **HAMMA**.  
**AMMA**, among ecclesiastical writers, a term used to denote an abbeſs or ſpiritual mother.  
**AMMÆA**, in geography. See **AMED**.  
**AMMAN**, or **AMMANT**, in the German and Belgic policy, a judge who has the cognizance of civil cauſes.  
**AMMANT**, is alſo uſed among the French for a public notary, or officer who draws up inſtruments and deeds.  
**AMMANNIA**, in botany, a genus of the tetrandria monogynia claſs. The corolla conſiſts of four petals inſerted into the calix, which has eight teeth. The capſule has four cells. There are three ſpecies of ammannia, *viz.* the latifolia, and ramiſior, both natives of America; and the baccifera, a native of China.  
**AMMERGAW**, or **AMMERLAND**, a ſmall territory in Weſtphalia, belonging to the King of Denmark.  
**AMMI**, in botany, a genus of the pentandria digynia claſs. The involucreum is pinnated; and the flowers are all hermophradite, with radiated petals. There are two ſpecies of the ammi, *viz.* the majus and glaucifolium, both natives of Europe.  
**AMMINIÆ** *uva*, a name ſometimes given to a ſpecies of vine. See **VITIS**.  
**AMMITES**, in natural hiſtory, the name of a congeries of ſtalagmite. See **STALAGMITÆ**.  
**AMMOCOETUS**, in ichthyology. See **AMMODYTES**.  
**AMMOCHRYSOS**, the name of a ſpecies of mica, a ſtone common in Germany. See **MICA**.  
**AMMODYTES**, or **SAND-EEL**, in ichthyology, a genus of fiſhes belonging to the order of apodes. This fiſh reſembles an eel, and ſeldom exceeds a foot in length. The head of the ammodytes is compressed, and narrower than the body; the upper jaw is larger than the under; the body is cylindrical, with ſcales hardly perceptible. There is but one ſpecies of the ammodytes, *viz.* the tobianus, a native of Europe. This fiſh gathers itſelf into a circle, and pierces the ſand with its head in the centre.  
**AMMON**, or **HAMMON**, in heathen antiquity. See **HAMMON**.  
**Cornua AMMONIS**, in natural hiſtory. See **SNAKE-STONES**.  
**AMMONIAC**, the name of a gum-reſin extracted from an African plant. It is transported hither in the form of drops or granules, and ſometimes in large maſſes composed of theſe granules adhering together. The beſt kind of it is that which is freeſt of drops, of a yellowiſh colour, and a bitteriſh taſte. It is much uſed in obſtructions of the viſcera and inſarctions of the lungs.  
*Sal* **AMMONIAC**. See **ARMONIAC**.  
**AMMONITÆ**. See **SNAKE-STONES**.  
**AMMUNITION**, a general term for all warlike proviſions, but more eſpecially powder, ball, &c.

Ammunition, arms, utenſils of war, gun-powder, imported without licence from his Maſteſty, are, by the laws of England, forfeited, and triple the value.

And again, ſuch licence obtained, except for furniſhing his Maſteſty's public ſtores, is to be void, and the offender to incur a premunire, and to be diſabled to hold any office from the crown.

**AMMUNITION** *bread, ſhoes, &c.* ſuch as are ſerved out to the ſoldiers of an army or garrifon.

**AMNA**, among ancient phyſicians. See **AMNIS**.

**AMNESTY**, in matters of policy, an act by which two parties at variance promiſe to pardon and bury in oblivion all that is paſt.

Amneſty is either general and unlimited, or particular and reſtrained, though moſt commonly univerſal, without condition or exceptions; ſuch as that which paſſed in Germany at the peace of Oſnaburg in the year 1648.

**AMNESTY**, in a more limited ſenſe, denotes a pardon granted by a prince to his rebellious ſubjects, uſually with ſome exceptions: ſuch was that granted by Charles II. at his reſtoration.

**AMNIMODAR**, in aſtrology, denotes the planet which rectifies a nativity, or rather the method of doing it.

**AMNIOS**, in anatomy, a thin pellucid membrane which ſurrounds the foetus in the womb. See **ANATOMY**, Part VI.

**AMNIS** *alcalifatus*, a term for water impregnated with an alkali. See **ALKALI**.

**AMOER**, in geography, the ſame with **Amour**. See **AMOUR**.

**AMOER** is alſo an iſland ſituated eaſt from Niulham, and north-weſt from the land of Yeſſo.

**AMNITES**. See **AMMITES**.

**AMOEBAEUM**, in ancient poetry, a kind of poem, reſenting a diſpute between two perſons who are made to answer each other alternately; ſuch are the third and ſeventh of Virgil's eclogues.

**AMOL**, a city of Thabarifan in Aſia upon the Gihun. See **GIHUN**.

**AMOMUM**, in botany, a genus of the monandria monogynia claſs. The corolla of the amomum is cut into four ſegments, one of which ſpreads open. There are four ſpecies of this genus, *viz.* the zinziber, zerumbet, cardamom, and grana paradifi, all natives of the Indies. See **CARDAMOM**, and **GRANA PARADISI**.

**AMORBACH**, a ſmall city of Franconia, in Germany, belonging to the elector of Mentz.

**AMORGO**, an iſland of the Archipelago, about ninety miles north of Candia, lying in E. long. 26° 15', and N. lat. 37°.

**AMORPHA**, in botany, a genus of the diadelphia decandria claſs, of which there is but one ſpecies, *viz.* the fruticoſa. The vexillum of the corolla is ovated and concave; it has no alæ or carina. It is a native of Carolina, and is ſometimes called *barba Jovis Americana*.

**AMORTIZATION**, in law, the alienation of lands or tenements to a corporation or fraternity and their ſucceſſors. See **MORTMAIN**.

**AMOÛSSON**,

- AMOSSON**, a river of France, in the province of Languedoc.
- AMOVING**, the act of expelling a person from his place or office.
- AMOUR**, a large river of Asia, which, arising in Siberia, runs eastward through Chinese Tartary, and falls into the bay of Corea in the Indian Ocean.
- AMOY**, an island on the south-west coast of China, situated in E. long. 118°, N. lat. 25°.
- AMPANA**, in botany, an obsolete name of the borassus. See **BORASSUS**.
- AMPELIS**, in botany. See **VITIS**.
- AMPELITES**, CANNEL-COAL, a hard, opaque, fofile, inflammable substance, of a black colour. It does not effervesce with acids; it is capable of a fine polish, and for that reason is turned into a number of toys, as snuff-boxes, and the like.
- AMPER**, or **AMPOR**, an Essex term for a phlegmon. See **PHLEGMON**.
- AMPEZO**, a town in the Tyroleze, belonging formerly to the Venetians, but now to the house of Austria.
- AMPERES**, in antiquity, a kind of vessels wherein the rowers plied two oars at the same time, one with the right hand, and another with the left.
- AMPHIARTHROSIS**, in anatomy, a term for such junctures of bones as have an evident motion, but different from the diarthrosis, &c. See **DIARTHROSIS**.
- AMPHIBIA**, in zoology, the name of Linnæus's third class of animals, including all those which live partly in water, and partly on land. This class is subdivided into three orders, viz. 1. The amphibia reptiles; the amphibia serpentes; and the amphibia nantes. See **NATURAL HISTORY**.
- AMPHIBIOUS**, in botany, the same with aquatic. See **AQUATIC**.
- AMPHIBLESTROIDES**, in anatomy, a name by which some call the retina of the eye. See **RETINA**.
- AMPHIBOLIA**. See the next article.
- AMPHIBOLOGY**, in grammar and rhetoric, a term used to denote a phrase susceptible of two different interpretations. Amphibology arises from the order of the phrase, rather than from the ambiguous meaning of a word.
- AMPHIBRACHYS**, in ancient poetry, the name of a foot consisting of three syllables, whereof that in the middle is long, and the other two short; such is the word [ābirē].
- AMPHICTYONS**, in Grecian antiquity, an assembly composed of deputies from the different states of Greece, and resembling, in some measure, the diet of the German empire.
- The amphictyons met regularly at Delphi twice a year, viz. in spring and autumn, and decided all differences between any of the Grecian states, their determinations being held sacred and inviolable.
- AMPHIDROMIA**, in antiquity, constituted part of the lustration of infants. See **LUSTRATION**.
- AMPHIDRYON**, in ecclesiastical writers, denotes the veil or curtain which was drawn before the door of the bema in ancient churches.
- AMPHIMACER**, in ancient poetry, a foot consisting
- of three syllables, whereof the first and last are long, and that in the middle short: such is the word [cāstītās].
- AMPHIPNEUMA**, with physicians, signifies great difficulty of breathing.
- AMPHIPOLES**, in antiquity, the principal magistrates of the city of Syracuse in Sicily, called Archons at Athens. See **ARCHON**.
- AMPHIPOLIS**, or **STRYMON**, a town of European Turkey, once the capital of Macedonia, situated in E. long. 40° 5', and N. lat. 41° 30'.
- AMPHIPPIL**, in Grecian antiquity, soldiers who, in war, used two horses without saddles, and were dexterous enough to leap from one to the other.
- AMPHIPRORÆ**, in the naval affairs of the ancients, vessels with a prow at each end. They were used chiefly in rapid rivers and narrow channels, where it was not easy to tack about.
- AMPHIPROSTYLE**, in the architecture of the ancients, a temple which had four columns in the front, and as many in the face behind.
- AMPHISBÆNA**, in zoology, a genus of serpents, belonging to the order of amphibia serpentes, so called from the false notion of its having two heads, because it moves with either end foremost.
- The head of the amphisbæna is small, smooth, and blunt; the nostrils are very small; the eyes are minute and blackish; and the mouth is furnished with a great number of small teeth. The body is cylindrical, about a foot long, and divided into about 200 annular convex segments like those of a worm; and it has about 40 longitudinal streaks, of which 12 on each side are in the form of small crosses like the Roman X; the anus is a transverse slit; and the last ring or segment of the belly has eight small papillæ, forming a transverse line before the anus; the tail, &c. all the space below the anus, is short, consisting of thirty annular segments, without being marked with the cross-lines, and is thick and blunt at the point. The colour of the whole animal is black, variegated with white; but the black prevails most on the back, and the white on the belly. It has a great resemblance to a worm, living in the earth, and moving equally well with either end foremost. There are but two species, viz. 1. the fuliginosa, which answers exactly to the above description, and is found in Lybia, and in different parts of America. 2. The alba, which is totally white, is a native of both the Indies, and is generally found in ant-hillocks. The bite of the amphisbæna is reckoned to be mortal by many authors; but as it is not furnished with dogfangs, the usual instruments of conveying the poison of serpents, later writers esteem it not to be poisonous. They feed upon ants and earth-worms, but particularly the latter. See plate XI. fig. 2.
- AMPHISCII**, among geographers, a name applied to the people who inhabit the torrid zone. The Amphiscii, as the word imports, have their shadows one part of the year towards the north, and at the other towards the south, according to the sun's place in the ecliptic. They are also called Ascii. See **ASCII**.

**AMPHISMILA**, a dissecting-knife, with a double edge.

**AMPHITANE**, among ancient naturalists, a stone said to attract gold, as the loadstone does iron.

**AMPHITAPA**, in antiquity, a garment frized or shagged on both sides, which was laid under persons going to sleep.

**AMPHITHEATRE**, in antiquity, a spacious edifice, built either round or oval, with a number of rising seats, upon which the people used to behold the combats of gladiators, of wild beasts, and other sports.

Amphitheatres were at first only of wood; and it was not till the reign of Augustus, that Statilius Taurus built one, for the first time, of stone. The lowest part was of an oval figure, and called arena, because, for the conveniency of the combatants, it was usually strewed with sand; and round the arena were vaults stiled *caveæ*, in which were confined the wild beasts appointed for the shews.

Above the *caveæ* was erected a large circular peristyle, or podium, adorned with columns. This was the place of the emperors, senators, and other persons of distinction.

The rows of benches were above the podium. Their figure was circular; and they were entered by avenues, at the end of which were gates, called vomitorie.

The most perfect remains we now have of amphitheatres, are that of Vespasian, called the coliseum, that at Verona in Italy, and that at Nîmes in Languedoc.

**AMPHITHEATRE**, in gardening, a temple erected on a rising ground, of a semicircular figure. These amphitheatres are formed of ever-greens, observing always to plant the shortest growing trees in the front, and the tallest behind. They are also made of slopes on the sides of hills, and covered with turf, being formerly esteemed great ornaments in gardens; but they are now generally excluded, as the natural slope of such hills is, to persons of true taste, far more beautiful than the stiff angular slopes of these amphitheatres.

**AMPHITHURA**, in the ancient churches, was the veil or curtain separating the chancel from the rest of the church.

**AMPHODONTA**, a term for animals who have teeth in both jaws.

**AMPHORA**, in antiquity, a liquid measure among the Greeks and Romans. The Roman amphora contained forty-eight sextaries, and was equal to about seven gallons one pint English wine-measure; and the Grecian or Attic amphora contained one third more. Amphora was also a dry measure, likewise in use among the Romans, and contained three bushels.

**AMPHORA**, among the Venetians, the largest measure used for liquids. It contains four bigorzas, the bigorza being four quarts, the quart four sachie, and each sachie four leras; but, by wholesale, the amphora is fourteen quarts, and the bigorza three quarts and a half.

**AMPHORA**, in astronomy, a name sometimes used for one of the twelve signs of the zodiac, more usually called aquarius. See **AQUARIUS**.

**AMPHOTIDES**, in antiquity, a kind of armour or

covering for the ears, worn by the ancient pugiles, to prevent their adversaries from laying hold of that part.

**AMPHTHILL**, a pretty town in the heart of Bedfordshire in England.

**AMPLIATION**, in a general sense, denotes the act of enlarging or extending the compass of a thing.

**AMPLIATION**, in Roman antiquity, was the deferring to pass sentence in certain causes. This the judge did, by pronouncing the word *amplius*; or by writing the letters N. L. for *non liquet*; thereby signifying, that as the cause was not clear, it would be necessary to bring further evidence.

**AMPLIFICATION**, in rhetoric. See **EXAGGERATION**.

**AMPLITUDE**, in astronomy, an arch of the horizon intercepted between the east or west point, and the centre of the sun, or a planet at its rising and setting, and so is either north and south, or ortive and occasive. See **ASTRONOMY**.

*Magnetical* **AMPLITUDE**, the different rising or setting of the sun from the east or west points of the compass. It is found by observing the sun, at his rising and setting, by an amplitude-compass.

**AMPLITUDE** of the range of a projectile, the horizontal line, subtending the path in which the projectile moved.

**AMPULLA**, in antiquity, a round big-bellied vessel which the ancients used in their baths, to contain oil for anointing their bodies. It was also a cup made of glass, and sometimes of leather, for drinking out of at table.

**AMPULLACEÆ conchæ**, in natural history. See **DOLIA**.

**AMPURIAS**, a town of Spain, capital of the district of Ampouzdán in Catalonia, and situated in E. long. 2° 50', and N. lat. 42° 15'.

**AMPUTATION**, in surgery, the cutting off a limb, or any part, from the body of an animal. See **SURGERY**, title, *Of amputation*.

**AMRAS**, a strong castle in the Tyroleze, E. long. 12° 10', N. lat. 47°.

**AMSDORFIANS**, in church-history, a sect of Protestants in the XVIth century, who took their name from Amsdorf their leader. They maintained, that good works were not only unprofitable, but were obstacles to salvation.

**AMSEGETES**, in Roman antiquity, those whose land bordered upon a public road.

**AMSTERDAM**, a large and beautiful city of Holland, situated on the river Amstel, and an arm of the sea, called Wye, a little eastward of the Zuyder-sea, in 4° 30' E. long. and 52° 20' N. lat.

It is computed to be half as big as London; and, in point of trade, equal to any town in the known world; there being people in it of almost every nation and religion of Europe, who apply themselves with the utmost diligence to heap up wealth, not with a view to enjoy it, but to have the pleasure of dying rich.

**AMSTERDAM**, is also the name of a town of the Curacoes, in America: likewise the name of three islands, one of which lies in the Indian ocean, between New Holland and Madagafcar; the second between Peru and



and the islands of Solomon; and the third in the Chinese sea, between Japan, and the island Formosa.

**AMULET**, a charm against witchcraft, or diseases, &c.

These amulets were made of stone, metal, simples, animals, and, in short, of every thing that imagination could suggest. Amulets sometimes consisted in strange unmeaning words, characters and sentences.—The ancients were extremely fond of amulets. Notwithstanding the progress of learning and refinement, there is not any country in Europe, even at this day, who do not believe in some charm or other.

**AMULET**, in cookery. See **OMELET**.

**AMULETICS**, among physicians, a name given to all medicines which are supposed to act as charms.

**AMURCA**, the name of an antiquated medicine, prepared by boiling the recrement or dregs of oil of olives to the consistence of honey, and used as an astringent.

**AMURCA**, in anatomy. See *Capsula atrabilaria*.

**AMUY**, a city of India, beyond the Ganges, near the lake Chiamai, on the borders of the kingdom of Kanduana.

**AMY**, in law, the next friend or relation to be entrusted for an infant. See **PROCHEN**.

*Alien AMY*, signifies a foreigner here, subject to some foreign prince, or power, in friendship with us.

**AMYGDALA**, the fruit of the almond-tree.

**AMYGDALA** is likewise used for a species of echinus marinus, a shell-fish. See **ECHINUS**.

**AMYGDALÆ**, in anatomy. See **Tonsillæ**.

**AMYGDALOIDES lapis**, in Nat. hist. a fossile substance, resembling the kernel of an almond.

**AMYGDALUS**, or **ALMOND-TREE**, in botany, a genus of the icofandria monogynia class. The calix is divided into five segments; and the corolla consists of five petals. The species are three, viz. the persica, or peach-tree; the communis, a native of Mauritania; and the nana, a native of Asia. Almonds are used in medicine as emollient, &c.

**AMYLON**, or **AMYLUM**, a term given to starch. See **STARCH**.

**AMYRBERIS**, in botany. See **BERBERIS**.

**AMYRIS**, in botany, a genus of the decandria monogynia class. The flower consists of four oblong petals.

The stygmia is quadrangular; the fruit is a berry of the drupa kind. There are four species of this genus, viz. The elemifera, maritima, toxifera, and balsamifera, all natives of America.

**AMYTHAONIS emplastrum**, a plaster composed of gum ammoniac, wax, bellium, &c. supposed by the ancients to be useful in convulsions.

**AMZEL**, in ornithology, the English name of a species of **turdus**. See **TURDUS**.

**AN JOUR and WASTE**, in law, signifies a forfeiture of lands for a year and a day to the king, by persons committing petit treason and felony, and afterwards the land falls to the lord.

**ANA**, among physicians, denotes a quantity equal to that of the preceding ingredient. It is abbreviated thus,  $\bar{a}$ , or  $\bar{a}$ .

**ANA**, among occult philosophers, a term used to denote

the human mind, from whence some will have *anapsalta*, a dæmon invoked by sick persons, to be derived.

**ANABAO**, one of the Molucca islands, S. W. from Timor.

**ANABAPTISTON**, the same with abaptiston. See **ABAPTISTON**.

**ANABAPTISTS**, a sect or denomination of Christians, who deduce their original from the apostolic age. This name was given them by their opponents, soon after the Reformation, by way of scorn, and imports *re-baptizing*; but this charge they disclaim, by denying that the sprinkling, or pouring of water, upon infants has any relation at all to the scripture-ordinance of baptism, either as to its *subjects* or *mode*.

Though they believe the salvation of elect infants; yet they deny their being the proper subjects of baptism: Because they can find neither precept nor example for such a practice in the N. Testament: Because Christ's commission to baptize appears to them to restrict this ordinance to such only as are taught, or made disciples, and believe the gospel, Mat. xxviii. 19. Mark xvi. 16.: Because the apostles, in executing Christ's commission, never baptized any but those who were first instructed in the Christian faith, and professed their belief of it, Acts ii. 41. viii. 12. xviii. 8.: And because the nature and design of the ordinance is such as can be of no advantage to infants, it being a sign and representation of spiritual blessings, intended to impress the mind of the person baptized with a comfortable sense of what is signified thereby, 1 Pet. iii. 21.; and as infants can neither discern the sign nor the thing signified, so they think they can reap no benefit from it, any more than from the Lord's supper, or any other ordinance of the gospel.

They repel the argument drawn from circumcision, by distinguishing betwixt the Old and New Testament dispensations, and betwixt the natural and spiritual seed of Abraham, Rom. ix. 8. Gal. iv. 22, 23, 28, 31. and maintain, that as circumcision belonged to the carnal birth, so baptism belongs only to the spiritual birth, or *those who are of faith*, Gal. iii. 7. Our Lord's words in Mark x. 13, 14. they consider as having no relation to infant-baptism, as he there neither enjoins nor exemplifies it; and they distinguish betwixt those who may be subjects of the kingdom of heaven in God's sight, and these whom he points out to us as proper visible subjects of gospel-ordinances. The argument from the apostles their baptizing whole houses, they answer, by shewing that these houses heard the word, believed, were comforted, and abounded in good works, Acts xvi. 32, 34, 40. and xviii. 8. 1 Cor. xvi. 15, 16. and so could not be infants.

The mode or manner of baptism they affirm to be *dipping* or *immersing* the whole body in water. This they say is the primary and proper meaning of the original word *Baptizo*, to dip, immerse, or plunge. In support of this sense of the word, they produce other places in the N. Testament where it is so rendered, as Mat. xxvi. 23. Luke xvi. 24. John xiii. 26. Rev. xix. 13. as also the circumstances of our Lord's baptism

tism in Jordan, Mat. iii. 16. Mark i. 9, 10. and of the eunuch's, Acts viii. 38, 39. and the reason of John's baptizing in Enon, John iii. 23. Hence they affirm, that no other mode can be called baptism, or so fitly represent communion with Christ in his death, burial, and resurrection, which is expressly the design of baptism, Rom. vi. 3, 4, 5.

Great troubles were occasioned in Germany by some who professed this tenet; but of all places where they prevailed, none suffered so much by them as the town of Munster. The Anabaptists, however, of Holland and Frizland disapproved of their seditious behaviour: and at present, though this sect still subsists, as well in Britain as abroad, yet they no longer pretend to be divinely inspired; they no longer oppose magistrates, nor preach up a community of goods. Those of them in England differ very little from the Protestant dissenters, except in rejecting infant-baptism; as appears from their confession of faith published 1689.

Within these four years, the Anabaptists have formed a congregation in Edinburgh, (which is the first appearance they ever made in Scotland), and seem to be a serious inoffensive people. They pray for the king and all inferior magistrates, and subject themselves (in civil matters) to every ordinance of man, for the Lord's sake. They consider the kingdom of Christ to be spiritual, and not of this world; and are strictly upon the congregational or independent plan, admitting of no jurisdiction or authority (in matters of religion) but that of the Great Lawgiver. Their church-officers are bishops (or elders) and deacons, and these they generally chuse from among themselves. They make the reading of the scriptures a part of their public service, and eat the Lord's supper every sabbath-day. Their disciples, before they are admitted into communion, are first baptized in the Water of Leith, which they do at all seasons of the year; and, on these occasions, they are generally attended by a great number of spectators\*.

**ANABLEPS**, in ichthyology, the trivial name of a species of cobitis. See **COBITIS**.

**ANABOLÆUM**, or **ANABOLE**, in antiquity, a kind of great or upper coat, worn over the tunica. See **TUNICA**.

**ANABOLEUS**, in antiquity, an appellation given to grooms of the stable, or equerries, who assisted their masters in mounting their horses. As the ancients had no stirrups, or instruments that are now in use for mounting a horse, they either jumped upon his back, or were aided in mounting by anabolei.

**ANABROCHISMUS**, an obsolete term among physicians, for removing offensive hairs from the eye-lids.

\* *As we chuse to avoid every kind of misrepresentation, especially in matters of religious opinion; and as the most genuine and satisfactory account of the origin and principles of any sect is to be expected from themselves; we applied to the preachers of the Anabaptist congregation at Edinburgh, from whom we had the above account — The same conduct will be observed with regard to every other sect of any note.*

**ANABROSIS**, signifies a corrosion by acrid humours.

**ANACA**, in ornithology, an obsolete name of a species of psittacus. **PSITTACUS**.

**ANACALYPTERIA**, in antiquity, festivals among the Greeks on the day that the bride was permitted to lay aside her veil, and appear in public. The word is derived from a verb which signifies to *uncover*.

**ANACAMPSEROS**, in botany, a synonyme of the portulaca, and several other plants.

**ANACAMPTERIA**, in ecclesiastical antiquity, a kind of little edifices adjacent to the churches, designed for the entertainment of strangers and poor persons.

**ANACAMPTIC**, a name applied by the ancients to that part of optics which treats of reflection, being the same with what is now called *catoptrics*. See **CATOPTRICS**.

**ANACARDIUM**, or **CASHEW-NUT-TREE**, in botany, a genus of the decandria monogynia class, of which there is but one species, *viz.* the occidentale, a native of the Indies. The calix is divided into five parts; the flower consists of one quinquefide petal; the fruit is a kidney-shaped nut, inclosed in a fleshy receptacle. The kernel is of the same nature with an almond: The acrid juice contained between the kernels is recommended for tetters and other cutaneous diseases.

**ANACATHARSIS**, signifies a salivation, or discharge of noxious humours by spitting.

**ANACATHARTICS**, properly signify such medicines as promote the discharge of saliva.

**ANACEPHALÆOSIS**, in rhetoric, the same with recapitulation. See **RECAPITULATION**.

**ANACHIMOUSSI**, a country in the island of Madagascar, bordering on the south with Manaboule.

**ANACHORET**, in church-history, denotes a hermit, or solitary monk, who retires from the society of mankind into some desert, with a view to avoid the temptations of the world, and to be more at leisure for meditation and prayer.

Such were Paul, Anthony, and Hilarion, the first founders of monastic life, in Egypt and Palestine.

Anachorets, among the Greeks, consist principally of monks, who retire to caves or cells, with the leave of the abbot, and an allowance from the monastery; or who, weary of the fatigues of the monastery, purchase a spot of ground, to which they retreat, never appearing again in the monastery, unless on solemn occasions.

**ANACHRONISM**, in matters of literature, an error with respect to chronology, whereby an event is placed earlier than it really happened, in which sense it stands opposed to *Parachronism*.

**ANACLASTICS**, that part of optics which considers the refraction of light. See **REFRACTION**, and **OPTICS**.

**ANACLASTIC glasses**. See **GLASS**.

**ANACLETERIA**, in antiquity, a solemn festival celebrated by the ancients when their kings or princes came of age, and assumed the reins of government. It is so called, because proclamation being made of this event to the people, they went to salute their prince during the anacleteria, and to congratulate him upon his new dignity.

**ANA-**

**ANACLINOPALE**, among the ancient athletes, a kind of wrestling, performed on the ground.

**ANACLINTERIA**, in antiquity, those parts of the trilinear couches on which a cushion was placed for supporting the head.

**ANACOLLEMA**, a composition of astringent powders, applied by the ancients to the head, to prevent fluctuations on the eyes.

**ANACREONTIC *verse***, in ancient poetry, a kind of *verse*, so called from its being much used by the poet Anacreon. It consists of three feet and an half, usually spondees and iambuses, and sometimes anapests: Such is that of Horace,

*Lydia, dic per omnes.*

**ANACRISIS**, among civilians, an investigation of truth, interrogation of witnesses, and inquiry made into any fact, especially by torture.

**ANACUICS**, in geography, a people of Brazil in America.

**ANACYCLUS**, in botany, a genus of the syngenesia polygamia superflua class. The receptacle of the anacyclus is paleaceous; the pappus emarginated; and the seeds have membranaceous edges. There are three species of this genus, *viz.* the creticus, orientalis, and valentinus, all natives of the east.

**ANADAVADÆA**, in ornithology, a barbarous name of a species of alauda. See **ALAUDA**.

**ANADEMA**, in antiquity, denotes the fillet which the kings of Persia wore round their head. It denotes also a kind of ornament which women wore on their heads like a garland.

**ANADIPLOSIS**, in rhetoric and poetry, a repetition of the last word of a line, or clause of a sentence, in the beginning of the next: Thus,

*Pierides, vos hæc facietis maxima Gallo:*

*Gallo, cujus amor, &c.*

*Et matutinis accredula vocibus instat,*

*Vocibus instat, & assiduas jacit ore querelas.*

**ANADOLI**, the name by which the Turks call Natolia. See **NATOLIA**.

**ANADOLI *bisfari***, a name given by the Turks to the castle of the Dardanelles, on the Asiatic side.

**ANADOSIS**, among physicians, the distribution of the aliment over the body.

**ANADROMOUS**, among ichthyologists, a name given to such fishes as go to the sea from the fresh waters at stated seasons, and return back again, such as the salmon, &c. See **SALMON**.

**ANÆDEIA**, in Grecian antiquity, a stool whereon the accused person was placed to make his defence.

**ANÆSTHESIA**, signifies a privation of the senses.

**ANAGALLIS**, in botany, a genus of the pentandria monogynia class. The corolla of this plant consists of one rotated petal. There are four species of anagallis, *viz.* the arvensis, or male pimpernel, a native of Britain; the monelli, a native of Verona; the latifolia and the linifolia, both natives of Spain. The anagallis is supposed to be deterfive and healing.

**ANAGARSKAYE**, a city of Muscovitish Tartary, in

the province of Dauria, near the source of the river Amour. See **AMOUR**.

**ANAGLYPHICE**, or **ANAGLYPTICE**, denotes the art of embossing. See **EMBOSSING**.

**ANAGNI**, a town of Italy in the Campagna di Roma, situated about 32 miles E. of Rome, in 13° 45' E. long. and 42° N. lat.

**ANAGNOSTA**, or **ANAGNOSTES**, in antiquity, a kind of literary servant, retained in the families of persons of distinction, whose chief business was to read to them during meals, or at any other time when they were at leisure.

**ANAGOGICAL**, signifies mysterious, transporting, and is used to express whatever elevates the mind.

**ANAGOGY**, or **ANAGOGE**, among ecclesiastical writers, the elevation of the mind to things celestial and eternal:

**ANAGRAM**, in matters of literature, a transposition of the letters of some name, whereby a new word is formed, either to the advantage or disadvantage of the person or thing to which the name belongs. Thus from Galenus, is formed Angelus; from James, Simea; and so of others.

**ANAGRAMMATIST**, a person who composes or deals much in anagrams.

**ANAGROS**, in commerce, a measure for grain used in some cities of Spain, particularly at Seville; 46 anagros make about 10½ quarters of London.

**ANAGYRIS**, in botany, a genus of the decandria monogynia class. This plant has a papilionaceous vexillum, the alæ of which are shorter than the carina. The capsule is a legumen. There is only one species of anagyris, *viz.* the fatida, a native of Spain, Sicily, and Italy. The leaves are said to be laxative, and the seeds emetic.

**ANALABE**, in the Greek church, a part of the dress of the eastern monks, answerable to the scapular of the west. See **SCAPULAR**.

**ANALECTA**, or **ANALECTES**, in antiquity, a servant whose employment it was to gather up the off-falls of tables.

**ANALECTA**, *analects*, in a literary sense, is used to denote a collection of small pieces, as essays, remarks, &c.

**ANALEMMA**, in geometry, a projection of the sphere on the plane of the meridian, orthographically made by straight lines and ellipses, the eye being supposed at an infinite distance, and in the east or west points of the horizon.

**ANALEMMA**, denotes likewise an instrument of brass or wood, upon which this kind of projection is drawn, with an horizon and cursor fitted to it, wherein the solstitial colure, and all circles parallel to it, will be concentric circles; all circles oblique to the eye, will be ellipses; and all circles whose planes pass through the eye, will be right lines.

The use of this instrument is to shew the common astronomical problems, which it will do, though not very exactly, unless it be very large.

**ANALEPSIS**, the augmentation or nutrition of an emaciated body.

**ANALECTICS**, restorative or nourishing medicines.

ANA-

**ANALOGICAL**, in a general sense, denotes something belonging to, or partaking of the nature of analogy.— Hence,

**ANALOGICAL syllogism**, is one whose force chiefly depends on the analogy between the two premises.

**ANALOGISM**, among logicians, the arguing from the cause to the effect.

**ANALGISTA**, among civilians, denotes a tutor who is not obliged to give an account of his conduct.

**ANALOGY**, in matters of literature, a certain relation and agreement between two or more things, which in other respects are entirely different.

There is likewise an analogy between beings that have some conformity or resemblance to one another; for example, between animals and plants; but the analogy is still stronger between two different species of certain animals.

Analogy enters much into all our reasoning, and serves to explain and illustrate. A great part of our philosophy has no other foundation than analogy, the utility of which consists in superseding all necessity of examining minutely every particular body; for it suffices us to know that every thing is governed by general and immutable laws, in order to regulate our conduct with regard to all similar bodies, as we may reasonably believe that they are all endowed with the same properties: Thus, we never doubt that the fruit of the same tree has the same taste.

**ANALOGY**, among geometers, denotes a similitude of ratios. See **RATIO**.

**ANALOGY**, in medicine, the resemblance observable between different diseases, which indicates a similar treatment,

**ANALOGY**, among grammarians, is the correspondence which a word or phrase bears to the genius and received forms of any language.

**ANALOGY of doctrine**, among critics, is the explaining the passage of an author, in a manner consistent with the system which he is known to have generally followed.

**ANALOGY**, in rhetoric, a figure of speech, otherwise called comparison. See **COMPARISON**.

**ANALYSIS**, in a general sense, is the resolution of something compounded, into its constituent parts. Hence,

**ANALYSIS**, among logicians, is the resolving of knowledge into original principles, by tracing things backward to their causes.

**ANALYSIS**, among mathematicians, the art of discovering the truth or falsehood of a proposition, or its possibility or impossibility. This is done by supposing the proposition, such as it is, true; and examining what follows from thence, until we arrive at some evident truth, or some impossibility, of which the first proposition is a necessary consequence; and from thence establish the truth or impossibility of that proposition.

**ANALYSIS**; in chemistry, the reducing of an heterogeneous or mixt body, into its original principles or component parts. See **CHEMISTRY**.

**ANALYSIS**, is also used to signify the anatomical dissection of an animal. See **ANATOMY**.

**ANALYSIS**, among grammarians, is the explaining the etymology, construction, and other properties of words.

**ANALYSIS of powers**, is the operation of resolving them into their roots, otherwise called evolution. See **ALGEBRA**, and **ARITHMETIC**.

**ANALYSIS**, is also used for a brief, but methodical illustration of the principles of a science; in which sense it is nearly synonymous with what we otherwise call a synopsis.

**ANALYSIS**, likewise denotes a table of the principal heads of a continued discourse, disposed in their natural order.

**ANALYST**, a person who makes use of the analytical method of resolving problems.

**ANALYTIC**, or **ANALYTICAL**, in a general sense, denotes something belonging to the analysis. See **ANALYSIS**. It is more particularly used for the mathematical and logical analysis, above explained.

**ANAMNESTICS**, among physicians, signs or symptoms from which the present state of the body is discovered.

**ANAMORPHOSIS**, in perspective, and painting, a monstrous projection, or representation of an image, on a plane or curve surface, which, beheld at a proper distance, shall appear regular, and in proportion. See **PERSPECTIVE**.

**ANANAS**, in botany, the trivial name of a species of bromelia. See **BROMELIA**.

**ANANCITIS**, in antiquity, a kind of figured stone, otherwise called *synochitis*, celebrated for its magical virtue of raising the shadows of the infernal gods.

**ANANTHOCYCLUS**, in botany. See **COLUTEA**.

**ANAPÆST**, in ancient poetry, a foot consisting of two short syllables, and one long: Such is the word *scōpūlōs*. It is just the reverse of the dactyl. See **DACTYL**.

**ANAPÆSTIC verses**, those consisting wholly or chiefly of anapæsts.

**ANAPES**, a town in Flanders, situated upon the river Marque, something more than a league's distance from Lille.

**ANAPHORA**, in rhetoric, the repetition of the same word or words in the beginning of a sentence, or verse: Thus Virgil,

*Pan etiam Arcadiū mecum se judice certet,  
Pan etiam Arcadiū dicat se judice victum.*

**ANAPHORA**, among physicians, the throwing off purulent matter by the mouth.

**ANAPHRODISIA**, signifies impotence, or want of power to procreate.

**ANAPLASIS**, signifies the replacing or setting a fractured bone.

**ANAPLEROSIS**, among physicians. See **PLETHORA**.

**ANAPLEROTICS**, medicines that promote the growth or granulation of the flesh, in wounds, ulcers, &c.

**ANAPODOPHYLLUM**, in botany. See **PODOPHYLLUM**.

**ANAPULA**, a province of Venezuela in South America.

ANA-

**ANAQUITTO**, a country of Peru, in South America, in the government of Quito.

**ANARCHY**, in matters of polity, such a confusion in the state, that no supreme authority is lodged either in the prince or other rulers, and consequently the people live at large, without subordination, or any respect for the laws.

**ANARICHAS**, in ichthyology, a genus of fishes of the order of apodes. The head of the anarichas is a little obtuse; the teeth are thick set and roundish. The six fore ones, both above and below, are conical and diverging; the inferior and palate molares are round; the branchiostege membrane has six rays; the body is somewhat cylindrical; the tail-fin is distinct. There is one species of this genus, *viz.* the anarichas lupus, or sea-wolf. It grows generally to four or five feet in length. The lapis bufonites or lycodentes is the teeth of the anarichas petrified. It is a native of the northern coast of England.

**ANARRHINON**, in botany. See **ANTIRRHINUM**.

**ANARRHOPIA**, among physicians, a tendency of the humours to the head or superior parts.

**ANAS**, in ornithology, a genus of birds belonging to the order of anseres. The beak of this genus is a little obtuse, covered with an epidermis or skin, gibbous at the base, and broad at the apex; the tongue is obtuse and fleshy; the feet are webbed and fitted for swimming. Under this genus Linnæus comprehends 38 species, *viz.* 1. The cygnus, or swan, with a semicylindrical black bill, yellow wax, and a white body. It is the wild swan of English authors, and a native of Europe and N. America. Linnæus says, they frequently visit Sweden after a thaw; and they are caught with apples in which a hook is concealed.

2. The cygnoides, with a semicylindrical bill, gibbous wax, and tumid eye-brows: It is the swan-goose of Ray, from Guinea. There is likewise a variety of this species, of a less size, called the goose of Muscovy.

3. The tadorna, with a flat bill, a compressed forehead, a greenish black head, and the body is variegated with white. It is the shell-drake of Ray, and frequents the sea-coasts of Europe.

4. The speculabilis, has a compressed bill, gibbous at the base, a black feathery carina, and a hoary head. It is the grey-headed duck of Edwards, and is a native of Sweden and Canada.

5. The fusca, is of a blackish colour, has a white spot behind the eyes, and a white line on the wings. The male of this species is distinguished by a gibbosity at the base of the bill. It is the black duck of Ray, and a native of the European seas.

6. The nigra, is totally black, and has a gibbosity at the base of the bill; the tail resembles a wedge; the female is brownish. It is the lesser black duck of Ray, and a native of Britain and Lapland.

7. The anser, has a semicylindrical bill; the upper part of the body is ash-coloured, but paler below; and the neck is streaked. It is the wild-goose of Ray, and is a native of Europe and America. There is a variety of this species from America, which Edwards calls the laughing-goose; it has a white ring at the base of the bill, and its neck is streaked. The anseres migrate in large

troops. 8. The erythropus, is of a grey colour, and has a white forehead. It inhabits the north of Europe.

9. The canadensis, is brown, the neck and head are black, and the throat white. It is a native of Canada.

10. The cœrulescens, is greyish above, and white underneath; the covert feathers of the wings and back are bluish. It is the blue-winged goose of Edwards, and a native of Canada.

11. The bernicla, is of a brown colour; with the head, neck, and breast black; and a white collar. It is the Brent-goose of Ray, and is a native of the northern parts of Europe.

12. The mollissima, or cutbert-duck of Ray, has a cylindrical bill, and the wax is divided behind and wrinkled. The feathers, which are very soft and valuable, fall off during incubation. The male is white above, but black below and behind; the female is greenish. It is a native of the north of Europe.

13. The moschata, or Muscovy duck of Ray, has a naked papillous face, and is a native of India.

14. The bahamensis, or Bahama duck, is grey, with a lead-coloured bill. It has a tawny spot on the sides, and a green yellowish spot on the wings. It is a native of Bahama.

15. The albeola, or little black and white duck, has a black back and wings; the head is bluish, and white on the hinder-part. It is a native of America.

16. The clypeata, or shoveller of Ray, has the end of its bill broad and rounded, and a crooked nail at the end of it. It is found near the European shores.

17. The strepera, or flat-billed duck of Aldrovandus, has the wings variegated with black, white, and red. It frequents the fresh waters of Europe.

18. The bucephala, or lesser duck of Catesby, has the back and wings black; and the head, both above and below, is interspersed with shining silky feathers. It frequents the fresh waters of N. America.

19. The clangula, or golden-eye of Ray, is variegated with black and white, and the head is interspersed with blackish green feathers; it has a white spot near the mouth. It dives much in quest of shell-fish; the eyes are of a shining gold colour.

20. The rustica, is brownish, or ash-coloured, with a white spot on the ears and wings. It is a native of N. America.

21. The perspicillata, or great black duck, is white on the top of the head and of the neck, and has a black spot on the bill, immediately behind the nostrils. It is a native of Canada.

22. The glaucion, or greater wild-duck of Ray, has the iris of the eyes yellow, a grey head, and white collar. It frequents the northern shores of Europe.

23. The penelops, or widgeon of Ray, has a sharpest tail, black below; the head is brown, and the forehead white. It inhabits the marshy parts of Europe.

24. The acuta, or sea-pheasant of Ray, has a long acuminate tail, black below, and a white line on each side of the back part of the head. It is a native of Europe.

25. The hyemalis, or long-tailed duck, has a tail shaped like a wedge, and long tail-feathers; the body is grey, and the temples white. It is a native of Europe and America.

26. The ferina, or red-headed widgeon of Ray, has ash-coloured wings, and a black rump. It frequents the maritime parts of Europe.

rope. 27. The querquedula, or first teal of Aldrovandus, has a green spot on the wings, and a white line above the eyes. It frequents the fresh waters of Europe. 28. The crecca, or common teal, has a green spot on the wings, and a white line both above and below the eyes. It frequents the fresh waters of Europe. This species is to be met with in Duddingston-loch, a fresh-water lake, within a mile of Edinburgh. 29. The histrionica, or dusky-spotted duck of Edwards, is of a brown colour, variegated with white and blue; has a double line on the ears and temples; the collar is white, and there is a white streak on the neck. It is a native of America. 30. The minuta, or little brown and white duck of Edwards, is of a greyish colour, with white ears, and the prime feathers of the wings blackish. It is a native of Canada. 31. The circia, or summer-teal of Ray, with the wings variegated with white spots, a white line above the eyes, and the beak and feet of an ash-colour. It frequents the lakes of Europe. 32. The autumnalis, or red-billed whistling duck of Edwards, is of a grey colour, with the prime feathers of the wings, the tail, and belly black; and the area of the wings yellow and white. It is a native of America. 33. The boschas, or common wild-duck of Ray; the intermediate tail-feathers of the drake are turned backward, and the bill is straight. It frequents the lakes of Europe. This duck feeds upon frogs and several sorts of insects.—The wild duck builds its nest among rushes or heath, near the water, and lays 12 or 14 eggs. At moulting-time, when they cannot fly, great numbers of them are taken with nets. Birds with flat bills, that find their food by groping, have three pair of nerves that extend to the end of their bills: these nerves are remarkably conspicuous in the head and bill of the wild-duck; and are larger than those of a goose, or any other bird yet known: This is the reason they grope for food more than any other bird whatever.—34. The adunca, or hook-billed domestic duck of Ray, has the same characters with the boschas, excepting that the bill is crooked. 35. The galericulata, or Chinese teal of Edwards, has a hanging crest; and on the hinder part of the back, on both sides, there is a crooked, flat, elevated feather; the crest is green and red; and the back is brown, and spotted with blue; the erect feathers on the back are red and blunt; one edge of the inmost wing-feather, when the wings are shut, is raised over the back, and is red, and like a sickle before. It is a native of China. 36. The sponsa, or summer-duck of Catesby, has a depending green crest, variegated with blue and white; the back is likewise variegated with blue and white; the breast is grey, and spotted with white; and the throat is white. It is a native of N. America. 37. The arborea, or black-billed whistling-duck of Edwards, is of a reddish brown colour, with a sort of crest on the head; the belly is spotted with black and white. It is a native of America. Sloane informs us, that this duck perches on trees; that it is about 20 inches long, from the end of the bill to the point of the tail; that it makes a kind of whistling noise, from which cir-

cumstance it has received its name. See plate XII. fig. 3. 38. The fuligula, or tufted-duck of Ray, has a hanging crest, a black body, and the wings and belly spotted with white. It is a native of Europe. The male of this species disappears during the incubation of the female.

*ANAS campestris*, in ornithology. See TETRAO.

ANASCAPTA, among physicians. See ANA.

ANASARCA, in medicine, a species of dropsy, in which the skin is puffed up and swelled, and the impression of the fingers remain, for some time, in the part to which they are applied, but principally in the legs. See MEDICINE, title, *Dropsy*.

ANASSA, or ANASSIS, in botany, a synonyme of a species of bromelia. See BROMELIA.

ANASTALTICS, in pharmacy. See STYPTICS.

ANASTASIS, a term among ancient physicians, for a rising up to go to stool. It also signifies the passage of any humour, when expelled from one part, and obliged to remove to another.

ANASTATICA, or rose of Jericho, in botany, a genus of the tetradynamia filiculosa class. The flower consists of four roundish petals, disposed in the form of a cross; the seed is a short bilocular pod, containing in each cell a single roundish seed. There are two species of the anastatica, viz. the hierochuntica, a native of the sandy parts of Palestine, and the shores of the Red-sea; and the Syriaica, a native of Syria.

ANASTOCCHICOSIS, signifies a resolution of the solids and fluids.

ANASTOMASIS, or ANASTOMOSIS, in anatomy, the opening of the mouths of vessels, in order to discharge their contained fluids. It is likewise used for the communication of two vessels at their extremities; as the inoculation of a vein with a vein, of an artery with an artery, or of an artery with a vein.

ANASTOMATICS, medicines supposed to have the power of opening the mouths of the vessels, and promoting the circulation; such as deobstruent, cathartic, and sudorific medicines.

ANASTROPHE, in rhetoric, denotes the inversion of the natural order of words.

ANATHEMA, among ecclesiastical writers, imports whatever is set apart, separated, or divided; but is most usually meant to express the cutting off a person from the privileges of society, and communion with the faithful.

The anathema differs from excommunication in the circumstances of being attended with curses and execrations. It was practised in the primitive church against notorious offenders; and the form of that pronounced by Synecius against one Andronicus, is as follows: "Let no church of God be open to Andronicus, but let every sanctuary be shut against him. I admonish both private men and magistrates, neither to receive him under their roof, nor to their table; and priests more especially, that they neither converse with him living, nor attend his funeral when dead."

Several councils also have pronounced anathemas against such as they thought corrupted the purity of the



*Fig. 2.*  
AMPHISBENA



*Fig. 3.*  
ANAS ARBOREA or Whitting Duck







the faith, and their decisions have been conceived in the following form: *Si quis dixerit, &c. anathema sit.*

There are two kinds of anathemas, the one judiciary, and the other abjuratory. The former can only be denounced by a council, a pope, or a bishop; the latter makes a part of the ceremony of abjuration, the convert being obliged to anathematize the heresy he abjures.

**ANATHEMA**, in heathen antiquity, was an offering or present made to some deity, and hung up in the temple. Whenever a person left off his employment, it was usual to dedicate the tools to the patron-deity of the trade. Persons too who had escaped from imminent danger, as shipwreck and the like, or had met with

any other remarkable instance of good fortune, seldom failed to testify their gratitude by some present of this kind.

**ANATHEMA** likewise denotes Christian offerings, otherwise called donations. See **DONATIONS**.

**ANATHEMATIZING**, the act of pronouncing an anathema against some person. See **ANATHEMA**.

**ANATICULA**, *little duck*, in the ancient Roman customs, a term of fondness used by lovers.

**ANATIFERA concha**, the trivial name of a species of the lepas, a testaceous animal. See **LEPAS**.

**ANATOLIA**, in geography, the same with Natolia. See **NATOLIA**.

**ANATOMICAL**, an epithet applied to any thing belonging to anatomy. See **ANATOMY**.

## A N A T O M Y.

**ANATOMY** is the art of dissecting the solid parts of animal bodies, with a view to discover their structure, connection, and uses.

**ANATOMY** is not only the basis of all medical knowledge, but is a very interesting object to the philosopher and natural historian.

In treating this useful subject, we shall divide it into the following parts: I. Of the **BONES**. II. Of the **MUSCLES**. III. Of the **ARTERIES**. IV. Of the **VEINS**. V. Of the **NERVES**. VI. Of such parts of the body as are not comprehended in any of the above, *s. g.* The **BRAIN**, **THORAX**, **ABDOMEN**, &c. &c.

### P A R T I.

### O F T H E B O N E S.

#### SECT. I. *Of the BONES in general.*

**BEFORE** we examine the structure of the bones, the periosteum, a membrane with which they are covered, must be described.

The periosteum can be divided into layers of fibres. The exterior ones, composed of the fibres of the muscles connected to the bones, vary in their number, size, and direction, and consequently occasion a very great difference in the thickness and strength of the periosteum of different bones. The internal layer is every where nearly of a similar structure, and has its fibres in the same direction with those of the bone to which they are contiguous.

Except where muscles, cartilages, or ligaments, are inserted into the periosteum, its external surface is connected to the surrounding parts by thin cellular membranes, which can easily be stretched considerably, but

shorten themselves whenever the stretching force is removed.

When the periosteum is torn off from bones, we see a great number of white threads produced from that membrane into them; and after a successful injection of the arteries with a red liquor, numerous vessels are not only seen on the periosteum, but most of the fibres sent from the membrane to the bone shew themselves to be vessels entering it, with the injected liquor in them; and when they are broken, by tearing off the periosteum, the surface of the bone is almost covered with red points.

The great sensibility of the periosteum in the deep-seated species of paronychia, in exostoses, nodi, tophi, and gummata, from a lues venerea, or whenever this membrane is in an inflamed state, is a sufficient proof that it is well provided with nerves; though they are perhaps too small to be traced.

The chief uses of the periosteum are: 1. To allow the muscles, when they contract or are stretched, to move

and slide easily upon the bones. 2. To keep in due order, and to support the vessels in their passage to the bones. 3. By being firmly braced on the bones, to assist in setting limits to their increase, and to check their overgrowth. 4. To strengthen the conjunction of the bones with their epiphyses, ligaments, and cartilages, which are easily separated in young creatures, when this membrane is taken away. 5. To afford convenient origin and insertion to several muscles which are fixed to this membrane. And, lastly, to warn us when any injury is offered to the parts it covers.

The BONES are the most hard and solid parts of the body, and generally of a white colour; only in a living creature they are bluish, which is owing to the blood in the small vessels under their surface.

Bones are composed of a great many plates, each of which is made up of fibres or strings united by smaller fibrils; which being irregularly disposed and interwoven with the other larger fibres, make a reticular work.—This texture is plainly seen in the bones of fetuses, which have not their parts closely compacted, and in the bones of adults, which have been burnt, long exposed to the weather, or whose composition has been made loose by diseases.

The plates are said to be firmly joined to each other by a great number of clavicle, or small bony processes, which, rising from the inner plates, pierce through some, and are fixed into the more external ones.

Though the exterior part of bones is composed of firm compact plates, yet they are all more or less cavernous internally. In some, the solid sides are brought so near, that little cavity can be seen; and in others, the cavities are so large, that such bones are generally esteemed to be hollow or fistular. But the internal spongy texture is most evident in young animals.

This spongy, cavernous, internal part of bones, is generally called their *cancelli* or *lattice-work*.

The twisting and windings which these cancelli make, and the interstices which they leave, differ considerably in figure, number, and size; and therefore form little cells, which are as different, but communicate with each other.

The cancelli sustain the membranous bags of the marrow which are stretched upon them, and thereby hinder these membranous parts from being torn or removed out of their proper places, in the violent motions and different postures which the bones are employed in.

The depressions between the fibres of the external plates of bones appear like so many furrows on their surface, into each of which the periosteum enters.

Both on the ridges and furrows, numerous little pits or orifices of canals are to be seen, by which the vessels pass to and from the bones.

After a successful injection, the arteries can be traced in their course from the pits to the plates and fibres.

We may conclude, from arteries being accompanied with veins, so far as we can trace them in every other part of the body, that there are also veins in the bones.

The bones of a living animal are so insensible that they can be cut, rasped, or burnt, without putting the creature to pain, and the nerves distributed in their substance

cannot be shewn by dissection; from which it might be inferred, that they have no nerves distributed to them: But the general tenor of nature, which bestows nerves to all the other parts, should prevent our drawing such a conclusion.

The vascular texture of bones must make them subject to obstructions, ecchymoses, ulcers, gangrene, and most other diseases which the softer parts are affected with; and therefore there may be a greater variety of *caries* than is commonly described.

On the internal surface of the solid parts of bones, there are orifices of canals, which pass outwards through the plates to open into other canals that are in a longitudinal direction, from which other transverse passages go out to terminate in other longitudinal canals; and this structure is continued through the whole substance of bones, both these kinds of canals becoming smaller gradually as they approach the outer surface.—These canals are to be seen to the best advantage in a bone burnt till it is white: When it is broken transversely, the orifices of the longitudinal canals are in view; and when we separate the plates, the transverse ones are to be observed.

Most bones have one or more large oblique canals formed through their sides for the passage of the medullary vessels.

The bones sustain and defend the other parts of the body.

Bones are lined within, as well as covered externally, with a membrane; which is therefore commonly called *periosteum internum*.

The internal periosteum is an extremely fine membrane; nay, frequently it has a loose reticular texture; and therefore it is compared by some to the arachnoide coat of the spinal marrow: so that we cannot expect to divide it into layers as we can divide the external periosteum. We can, however, observe its processes entering into the transverse pores of the bones, where probably they are continued to form the immediate canals for the marrow distributed through the substance of the bones; and along with them vessels are sent, as from the external periosteum, into the bone. These processes being of a very delicate texture, the adhesion of this membrane to the bone is so small, that it separates commonly more easily from the bone than from the marrow which it contains.

From the internal surface of the internal periosteum, a great number of thin membranes are produced; which, passing across the cavity, unite with others of the same kind, and form so many distinct bags, which communicate with each other; and these again are subdivided into communicating vesicular cells, in which the marrow is contained.

The MARROW is the oily part of the blood, separated by small arteries, and deposited in these cells. Its colour and consistence may therefore vary according to the state of the vessels, and their distribution on the membranes of the cells.

Besides the arteries already mentioned as being sent from the bones to the marrow, there is at least one artery for each bone; several bones have more, whose principal use is to convey and secrete this oily matter.

The

The blood, which remains after the secretion of the marrow, is returned by proper veins, which are collected from the membranes into one or two large trunks, to pass out at the same holes at which the arteries enter.

The vessels of the marrow, wrapt up in one common coat from the periosteum, pass through the bones by proper canals; the most considerable of which are about the middle of each bone, and are very oblique.

From the structure of the contents of the bones, we may judge how these parts, as well as others, may be subject to oedema, phlegmon, erysipelas, schirrhus, &c. and may these be led to a cure of each, before the common consequence, putrefaction, takes place, and frequently occasions the loss of the limb, if not of the patient.

The marrow is of very considerable use to the bones; for by entering their transverse canals, and passing from them into the longitudinal ones, it is communicated to all the plates, to soften and connect their fibres, whereby they are preserved from becoming too brittle.

When the marrow, after having served the uses mentioned, is reassumed into the mass of blood, it corrects the too great acrimony communicated to the saline particles of our fluids by their circulation and heat; in the same manner as lixivial salts are blunted by oil in making soap.

Since it is the nature of all oil to become thin and rancid when exposed long to heat, and bones have much oil in their firm hard substance, we may know why an ungrateful smell, and dark-coloured thin ichor, proceed more from corrupted bones than from other parts of the body; and we can understand the reason of the changes of colour which bones undergo, according to their different degrees of mortification.

Though bones so far agree in their structure and annexed parts, yet we may observe a considerable difference among them in their magnitude, figure, situation, substance, connection, uses, &c. Of these we shall only mention two, *viz.* that some bones are *broad and flat*, while others are *long and round*.

The *broad bones* have thin sides, by the plates being soon and equally sent off to form the lattice-work; which therefore is thicker, and nearly of an equal form all through. By this structure, they are well adapted to their uses, of affording a large enough surface for the muscles to rise from, and move upon, and of defending sufficiently the parts which they inclose.

The *round bones* have thick strong walls in the middle, and become very thin towards their ends, which is owing to very few plates separating at their middle; where, on that account, the cancelli are so fine and small that they are not taken notice of: But such bones are said to have a large reservoir of oil in this place. Towards their ends the lattice-work becomes very thick, and rather more complete than in the other sort of bones.—These round bones having strong forces naturally applied to them, and being otherwise exposed to violent injuries, have need of a cylindrical figure to resist external pressure, and of a considerable quantity of oil to preserve them from becoming too brittle. Besides which, they are advantageously provided with thick sides towards their middle, where the greatest forces are applied to injure

them; while their hollownes increases their diameter, and consequently their strength, to resist forces applied to break them transversely.

Many bones have protuberances, or processes, rising out from them. If a process stands out in a roundish ball, it is called *caput*, or *head*.—If the head is flattened, it obtains the appellation of *condyle*.—A rough unequal protuberance is called *tuberosity*.—When a process rises narrow, and then becomes large, the narrow or small part is named *cervix*, or *neck*.—Long ridges of bones are called *spines*.—Such processes as terminate in a sharp point, have the general name of *corona*, or *coronoid*, bestowed on them, though most of them receive particular names from the resemblance they have; or are imagined to have, to other substances, *e. g.* *mastoid*, *styloid*, &c.—Such processes as form brims of cavities, are called *supercilia*.

Processes serve for the advantageous origin and insertion of muscles, and render the articulations firm and stable.

In children these processes are real epiphyses, or distinct bones, which are afterwards united to the other parts; such are the styloid processes of the temporal bones, processes of the vertebrae, trochanters of the thigh, &c.

On the surfaces of a great many of the bones there are cavities, or depressions: If these are deep, with large brims, authors name them *cotyle*; if they are superficial, they obtain the designation of *glena*, or *glenoid*. These general classes are again divided into several species:—Of which *pits* are small roundish channels sunk perpendicularly into the bone;—*furrows* are long narrow canals, formed in the surface;—*notches* or *notches*, small breaches in the bone;—*sinuosities*, broad, but superficial depressions without brims;—*fossa*, large deep cavities, which are not equally surrounded by high brims;—*sinuses*, large cavities within the substance of the bones, with small apertures;—*foramina*, or holes, canals that pierce quite through the substance of the bones.—When this last sort of cavity is extended any long way within a bone, the middle part retains the name of *canal*, and its ends are called *holes*.

The cavities allow the heads of bones to play in them; they lodge and defend other parts; they afford safe passage to vessels, muscles, &c.

To far the greater number of bones, whose ends are not joined to other bones by an immoveable articulation, there are smaller ones annexed, which afterwards become scarce distinguishable from the substance of the bone itself. These are called *epiphyses*, or *appendices*. Some bones have one, others have two, three, or four of these appendices annexed by the means of cartilages, which are of a considerable thickness in children, but by age become thinner.

Several processes (*e. g.* *trochanters* of the thigh, *spine* of the *scapula*, &c.) have epiphyses; and processes frequently rise out from epiphyses; for example, at the lower end of the femur, ulna, tibia, &c.

The epiphyses are united chiefly to such bones as are destined for frequent and violent motion; and for this purpose they are wisely framed of a larger diameter than the

the bone they belong to; for by this means, the surface of contact between the two bones of any articulation being increased, their conjunction becomes firmer, and the muscles interted into them act with greater force, by reason of their axes being further removed from the center of motion.

The softness of the ends of bones may be of some advantage in the womb, and at birth, after which the ossification begins at different points to form epiphyses, before the ossification can extend from the middle to the ends of the bones.

However solid and compact adult bones are, yet they were once cartilages, membranes, nay, a mere jelly. This needs no further proof, than repeated observations of embryos when dissected: And how much more tender must the bones be before that time, when neither knife nor eye is capable to discover the least rudiments of them? By degrees they become more solid, then assume the nature of gristles, and at last ossify; the cohesion of their plates and fibres always increasing in proportion to their increased solidities; as is evident from the time necessary to unravel the texture of bones of people of different ages, or of dense and of spongy bones, or of the different parts of the same bone, and from the more tedious exfoliations of the bones of adults than of children.

The ossification of bones depends principally on their vessels being so disposed, and of such diameters, as to separate a liquor, which may easily turn into a bony substance, when it is deprived of its thinner parts; as seems plain from the observation of the callous matter separated after fractures and ulcers, where part of the bone is taken out: For in these cases, the vessels extending themselves, and the liquors added to them, are gradually formed into granulated flesh; which fills up all the space where the bone is taken from, then hardens, till it becomes as firm as any other part of the bone. This happens frequently, even when the ends of the diseased bone are at a considerable distance from each other.

The induration of bones is also greatly assisted by their being exposed, more than any other parts, to the strong pressure of the great weights they support, to the violent contraction of the muscles fixed to them, and to the force of the parts they contain, which endeavour to make way for their own further growth. By all this pressing force, the solid fibres and vessels of bones are thrust closer; and such particles of the fluids conveyed in these vessels as are fit to be united to the fibres, are sooner and more firmly incorporated with them, while the remaining fluids are forcibly driven out by the veins, to be mixed with the mass of blood. In consequence of this, the vessels gradually diminish as the bones harden. From which again we can understand one reason, why the bones of young animals sooner re-unite after a fracture than those of old; and why cattle that are put too soon to hard labour, seldom are of such large size as others of the same brood who are longer kept from labour.

From the effects of pressure only it is, that we can account for the bones of old people having their sides

much thinner, yet more dense and solid, while the cavities are much larger than in those of young people; and for the prints of muscles, vessels, &c. being so much more strongly marked on the surfaces of the former than of the latter, if they belong to people of near the same condition in life.—Pressure must likewise be the cause, which, in people of equal ages, makes these prints stronger in the bones of those who had much labour and exercise, than they are in people who have led an indolent unactive life.

Having thus considered the bones when single, we shall next shew the different manner of their conjunctions. To express these, anatomists have contrived a great number of technical terms; about the meaning, propriety, and classing of which, there has been a variety of opinions. Some of these terms it is necessary to retain, since they serve to express the various circumstances of the articulations, and to understand the writers on this subject.

The ARTICULATIONS are most commonly divided into three classes, *viz.* symphysis, synarthrosis, and diarthrosis.

*Symphysis*, which properly signifies the concretion or growing together of parts, when used to express the articulations of bones, does not seem to comprehend, under the meaning generally given to it, any thing relating to the form or motion of the conjoined bones; but by it most authors only denote the bones to be connected by some other substance; and as there are different substances which serve this purpose, therefore they divide it into the three following species:

1. *Synchondrosis*, when a cartilage is the connecting substance: Thus the ribs are joined to the sternum; thus the bodies of the vertebrae are connected to each other; as are likewise the ossa pubis.

2. *Synneurosis*, or *syndesmosis*, when ligaments are the connecting bodies, as they are in all the moveable articulations.

3. *Syffarcosis*, when muscles are stretched from one bone to another, as they must be where there are moveable joints.

The second class of articulations, the *synarthrosis*, which is said to be the general term by which the immoveable conjunction of bones is expressed, is divided into three kinds.

1. The *suture* is that articulation where two bones are mutually indented into each other, or as if they were sewed together. Thus the bones of the head are joined; thus epiphyses are joined to the bones, before their full connection and union with them.

2. *Composis* is the fixing one bone into another, as a nail is fixed in a board: Thus the teeth are secured in their sockets.

3. *Scindylefis*, or ploughing, when a thin lamella of one bone is received into a long narrow furrow of another: Thus the processus azygos of the sphenoid, and the nasal process of the ethmoid bone, are received by the vomer.

The third class, or *diarthrosis*, is the articulation where the bones are so loosely connected as to allow large motion. This is subdivided into three kinds.

The

The first is *enarthrosis*, or the ball and socket; when a large head is received into a deep cavity; as the head of the os femoris is into the acetabulum coxendicis.

The second is *arthrodia*, when a round head is received into a superficial cavity; as in the articulation of the arm-bone and scapula. These two species of diarthrosis allow motion to all sides.

The third is *ginglimus*, which properly signifies the hinge of a door or window; in it the parts of the bones mutually receive and are received, and allow of motion two ways: Workmen call it *charnal*.

The *ginglimus* is generally divided into three kinds, to which some give the names of *contiguous*, *distant*, and *compound*.

The first kind of *ginglimus* is, when a bone has several protuberances and cavities, which answer to as many cavities and processes of the other bone, with which it is articulated; as in the conjunction of the femur with the tibia.

The second species is, when a bone receives another at one end, and is received by the same bone at the other end; as in the radius and ulna.

The last sort is, when a bone receives another, and is received by a third; as in the oblique processes of the vertebrae.

If the moveable bones are not connected and kept firm by some strong substance, they would be luxated at every motion of the joints: and if their hard, rough, unequal surfaces were to play on each other, their motion would not only be difficult, but the loss of substance from attrition would be great. Therefore *ligaments* are made to obviate the first, and *cartilages* to prevent the other inconvenience. But because ligaments and cartilages turn rigid, inflexible, and rough, unless they are kept moist, a sufficient quantity of proper liquor is supplied for their lubrication, and to preserve them in a flexible state. Seeing then these parts are so necessary to the articulations, we shall next consider their structure, situation, and uses, so far as they are subservient to the bones, and their motions.

**LIGAMENTS** are white flexible bodies, thicker and firmer than membranes, and not so hard or firm as cartilages, without any remarkable cavity in their substance, difficultly stretched, and with little elasticity; serving to connect one part to another, or to prevent the parts to which they are fixed from being removed out of that situation which is useful and safe.

After maceration in water, the ligaments can easily be divided; and each ligamentous layer appears composed of fibres, the largest of which are disposed in a longitudinal direction.

The arteries of ligaments are very conspicuous after a tolerable injection, and the larger trunks of their veins are sometimes to be seen full of blood.

Such ligaments as form the sides of cavities, have numerous orifices of their arteries opening upon their internal surface, which keep it always moist: If we rub off that moisture, and then press the ligament, we can see the liquor oozing out from small pores; and we can

force thin liquors, injected by the arteries, into the cavities formed by ligaments.

These exhalent arteries must have corresponding absorbent veins, otherwise the cavities would soon be too full of liquor.

Ligaments then must be subject to the diseases common to other parts, where there is a circulation of fluids, allowance always being made for the size of vessels, nature of the fluids, and firmness of the texture of each part.

Some authors have alledged, that ligaments are insensible, and consequently that they have no nerves. But the violent racking pain felt on the least motion of a joint labouring under a rheumatism, the seat of which disease seems often to be in the ligaments, and the insufferable torture occasioned by incisions of ligaments, and by a collection of acrid matter in a joint, or by topi in the gout, would persuade us, that they are abundantly supplied with nerves.

The ligaments which connect the moveable bones commonly rise from the conjunction of the epiphyses of the one bone, and are inserted into the same place of the other; or where epiphyses are not, they come out from the cervix, and beyond the supercilia of the articulated bones; and after such a manner, in both cases, as to include the articulation in a purse or bag; with this difference, depending on their different motions, that where the motion is only to be in two directions, the ligaments are strongest on those sides towards which the bones are not moved; and when a great variety of motions is designed to be allowed, the ligaments are weaker than in the former sort of articulations, and are nearly of the same strength all round.

Part of the capsular ligaments is composed of the periosteum, continued from one bone to another, and their internal layer is continued on the parts of the bone or cartilage which the ligament includes.

Besides these common capsular ligaments of the joints, there are particular ones in several places, either for the firmer connection of the articulated bones, or for restraining and confining the motion to some one side; such are the cross and lateral ligaments of the knee, the round one of the thigh, &c.

From this account of the ligaments, we may conclude, that, *ceteris paribus*, in whatever articulation the ligaments are few, long, and weak, the motion is more free and quick; but luxations happen frequently: And, on the contrary, where the ligaments are numerous, short, and strong, the motion is more confined; but such a joint is less exposed to luxations.—Whence we may judge how necessary it is to attend to the different ligaments, and the changes which have been made on them by a luxation, when it is to be reduced.

Ligaments also supply the place of bones in several cases to advantage: Thus the parts in the pelvis are more safely supported below by ligaments, than they could have been by bone.—The ligaments placed in the great holes of the ossa innominata, and between the bones of the fore-arm and leg, afford convenient origin to muscles.—Immoveable bones are firmly connected by them;

of which the conjunction of the os sacrum and innominatum is an example.—They afford a socket for moveable bones to play in, as we see part of the altragalus does on the ligament stretched from the heel-bone to the scaphoid.

Numerous inconveniencies may arise from too long or short, strong or weak, lax or rigid ligaments.

**CARTILAGES** are solid, smooth, white elastic substances, between the hardness of bones and ligaments, and covered with a membrane, named *perichondrium*, which is of the same structure and use to them as the periosteum is to the bones.

Cartilages are composed of plates, which are formed of fibres, disposed much in the same way as those of bones are; as might be reasonably concluded from observing bones in a cartilaginous state before they ossify, and from seeing, on the other hand, so many cartilages become bony. This may be still further confirmed, by the exfoliation which cartilages are subject to, as well as bones.

The perichondrium of several cartilages, for example, those of the ribs and larynx, has arteries which can be equally well injected with those of the periosteum.

The granulated flesh which rises from the ends of metacarpal or metatarsal bones, when the cartilage exfoliates, after a finger or toe has been taken off at the first joint, is very sensible, from which the existence of nerves in cartilages may be inferred.

While cartilages are in a natural state, it is to be remarked, first, That they have no cavity in their middle for marrow. Secondly, That their outer surface is softest, which renders them more flexible. Thirdly, That they do not appear to change their texture near so much by acids as bones do. And, lastly, That as the specific gravity of cartilages is near a third less than that of bones, so the cohesion of their several plates is not so strong as in bones; whence cartilages laid bare in wounds or ulcers, are not only more liable to corrupt, but exfoliate much sooner than bones do.

Cartilages seem to be principally kept from ossifying, either by being subjected to alternate motions of flexion and extension, the effects of which are very different from any kind of simple pressure, or by being constantly moistened: Thus, the cartilages on the articulated ends of the great bones of the limbs, and the moveable ones placed between the moving bones in some articulations, which are obliged to suffer many and different flexions, and are plentifully moistened, scarce ever change into bone; while those of the ribs and larynx are often ossified.

The cartilages subservient to bones, are sometimes found on the ends of bones which are joined to no other; but are never wanting on the ends, and in the cavities of such bones as are designed for motion.

The uses of cartilages, so far as they regard bones, are, to allow, by their smoothness, such bones as are designed for motion, to slide easily without detrition, while, by their flexibility, they accommodate themselves to the several figures necessary in different motions, and, by their elasticity, they recover their natural position and shape as soon as the pressure is removed.—

This springy force may also assist the motion of the joint to be more expeditious, and may render shocks in running, jumping, &c. less.—To these, cartilages chiefly owe the security of the moveable articulations; For without them the bony fibres would sprout out, and intimately coalesce with the adjoining bone; whence a true ankylosis must necessarily follow; which never fails to happen when the cartilages are eroded by acrid matter, or ossified from want of motion or defect of liquor, as we see often happens after wounds of the joints, *par-darthrocace*, *scrophula*, and *spina ventosa*, on from old age, and long immobility of joints. The moveable cartilages interposed in joints, serve to make the motions both freer and more safe than they would otherwise be.—Those placed on the ends of bones that are not articulated, as on the spine of the os ilium, base of the scapula, &c. serve to prevent the bony fibres from growing out too far.—Cartilages sometimes serve as ligaments, either to fasten together bones that are immovably joined, such are the cartilages between the os sacrum and os ilium, the os pubis, &c. or to connect bones that enjoy manifest motion, as those do which are placed between the bodies of the true vertebræ, &c.—Cartilages very often do the office of bones to greater advantage, than these last could, as in the cartilages of the ribs, those which supply brims to cavities, &c.

Too great thickness or thinness, length or shortness, hardness or suppleness of cartilages, may therefore cause great disorders in the body.

The liquor, which principally serves to moisten the ligaments and cartilages of the articulations, is supplied by glands, which are commonly situated in the joint, after such a manner as to be gently pressed, but not destroyed by its motion. By this means, when there is the greatest necessity for this liquor, that is, when the most frequent motions are performed, the greatest quantity of it must be separated. These glands are soft and pappy, but not friable: In some of the large joints they are of the conglomerate kind, or a great number of small glandules are wrapt up in one common membrane. Their excretory ducts are long, and hang loose, like so many fringes, within the articulation; which, by its motion and pressure, prevents obstructions in the body of the gland or its excretories, and promotes the return of this liquor, when fit to be taken up by the absorbent vessels, which must be in the joints, as well as in the other cavities of the body; and, at the same time, the pressure on the excretory ducts hinders a superfluous unnecessary secretion, while the frimbriated disposition of these excretories does not allow any of the secreted liquor to be pushed back again by these canals towards the glands.

Very often these fountains of slimy liquor appear only as a net-work of vessels.—Frequently they are almost concealed by cellular membranes containing the fat;—and sometimes small simple mucous folliculi may be seen.

The different joints have these organs in different numbers and sizes; the conglomerate ones don't vary much, especially as to situation, in the similar joints of different bodies; but the others are more uncertain.

Upon pressing any of these glands with the finger, one can

can squeeze out of their excretories a mucilaginous liquor, which somewhat resembles the white of an egg, or serum of the blood; but it is manifestly salt to the taste. It does not coagulate by acids or by heat, as the serum does, but by the latter turns first thinner, and, when evaporated, leaves only a thin salt film.

The vessels which supply liquors for making the secretion of this mucilage, and the veins which bring back the blood remaining after the secretion, are to be seen without any preparation; and, after a tolerable injection of the arteries, the glands are covered with them.

In a sound state, we are not conscious of any sensibility in those glands; but, in some cases, when they inflame and suppurate, the most racking pain is felt in them: a melancholy, though a sure proof that they have nerves.

These mucilaginous glands are commonly lodged in a cellular substance; which is also to be observed in other parts of the bag formed by the ligaments of the articulation; and contains a fatty matter, that must necessarily be attenuated, and forced through the including membranes into the cavity of the joint, by the pressure which it suffers from the moving bones.

After the liquor of the articulations becomes too thin and unserviceable, by being constantly pounded and rubbed between the moving bones, it is reassumed into the mass of blood by the absorbent vessels.

## SECT. II. *Of the SKELETON.*

Among anatomists, *Skeleton* is universally understood to signify the bones of animals connected together, after the teguments, muscles, bowels, glands, nerves, and vessels are taken away.

A skeleton is said to be a natural one, when the bones are kept together by their own ligaments; and it is called *artificial*, when the bones are joined with wire, or any other substance which is not part of the creature to which they belonged.

The human skeleton is generally divided into the HEAD, the TRUNK, the SUPERIOR and the INFERIOR EXTREMITIES.

### OF THE HEAD.

By the *Head* is meant all that spheroidal part which is placed above the first bone of the neck. It therefore comprehends the cranium and bones of the face.

The cranium, helmet, or brain-case, consists of several pieces, which form a vaulted cavity, for lodging and defending the brain and cerebellum, with their membranes, vessels, and nerves.

The cavity of the cranium is proportioned to its contents. Hence such a variety of its size is observed in different subjects; and hence it is neither so broad nor so deep at its fore-part, in which the anterior lobes of the brain are lodged, as it is behind, where the large posterior lobes of the brain, and the whole cerebellum, are contained.

The external surface of the upper part of the cranium is very smooth, and equal, being only covered with the periosteum, (common to all the bones; but in the skull, distinguished by the name of pericranium), the thin frontal and occipital muscles, their tendinous aponeurosis, and with the common teguments of the body; while the external surface of its lower part has numerous risings, depressions, and holes, which afford convenient origin and insertion to the muscles that are connected to it, and allow safe passage for the vessels and nerves that run through and near it.

The internal surface of the upper part of the skull is commonly smooth, except where the vessels of the dura mater have made furrows in it, while the bones were soft.—Surgeons should be cautious when they trepan here, lest, in sawing or raising the bone where such furrows are, they wound these vessels.—In the upper part of the internal surface of several skulls, there are likewise pits of different magnitudes and figures, which seem to be formed by some parts of the brain being more luxuriant and prominent than others. Where these pits are, the skull is so much thinner than any where else, that it is often rendered diaphanous, the two tables being closely compacted without a diploe; the want of which is supplied by vessels going from the dura mater into a great many small holes observable in the pits.—

The knowledge of these pits should teach surgeons to saw cautiously and slowly through the external table of the skull, when they are performing the operation of the trepan; since, in a patient whose cranium has these pits, the dura mater and brain may be injured, before the instrument has pierced near the ordinary thickness of a table of the skull.—The internal base of the skull is extremely unequal for lodging the several parts and appendices of the brain and cerebellum, and allowing passage and defence to the vessels and nerves that go into, or come out from these parts.

The bones of the cranium are composed of two tables, and intermediate cancelli, commonly called their *diploe*. The external table is thickest; the inner, from its thinness and consequent brittleness, has got the name of *vitrea*.

The diploe has much the same texture and uses in the skull, as the cancelli have in other bones.

The diploe of several old subjects is so obliterated, that scarce any vestige of it can be seen; neither is it observable in some of the hard craggy bones at the base of the skull. Hence an useful caution to surgeons who trust to the bleeding, want of resistance, and change of sound, as certain marks, in the operation of the trepan, for knowing when their instrument has sawed through the first table, and reached the diploe.

The cranium consists of eight bones, six of which are said to be proper, and the other two are reckoned common to it and to the face.—The six proper are, the os frontis, two ossa parietalia, two ossa temporum, and the os occipitis.—The common are, the os ethmoides, and sphenoides.

The os frontis forms the whole fore-part of the vault; the two ossa parietalia form the upper and middle part of it; the ossa temporum compose the lower part of the sides;

sides; the os occipitis makes the whole hinder-part, and some of the base; the os ethmoides is placed in the fore-part of the base; and the os sphenoides is in the middle of it.

These bones are joined to each other by five sutures; the names of which are, the coronal, lambdoid, sagittal, and two squamous.

The coronal suture is extended over the head, from within an inch or so of the external canthus of one eye, to the like distance from the other; which being near the place where the ancients wore their vittæ, coronæ, or garlands, this suture has hence got its name.—Though the indentations of this suture are conspicuous in its upper part, yet an inch or more of its end on each side has none of them; for it is squamous and smooth there.

The lambdoidal suture begins some way below, and farther back than the vertex or crown of the head, whence its two legs are stretched obliquely downwards, and to each side, in the form of the Greek letter  $\Lambda$ , and are generally said to extend themselves to the base of the skull.

This suture is sometimes very irregular, being made up of a great many small sutures, which surround so many little bones that are generally larger and more conspicuous on the external surface of the skull than internally. These bones are generally called *triquetra*, or *Wormiana*.

The sagittal suture is placed longitudinally, in the middle of the upper part of the skull, and commonly terminates at the middle of the coronal, and of the lambdoid sutures; between which it is said to be placed, as an arrow is between the string and bow.—However, this suture is frequently continued through the middle of the os frontis, down to the root of the nose; which oftener happens in women than men.

The squamous agglutinations, or false sutures, are one on each side, a little above the ear, of a semicircular figure, formed by the overlapping (like one scale upon another) of the upper part of the temporal bones, on the lower part of the parietal, where, in both bones, there are a great many small risings and furrows, which are indented into each other; though these inequalities do not appear till the bones are separated.

The bones of the skull are joined to those of the face by schyndelefsis and sutures.—The schyndelefsis is in the partition of the nose.—The sutures said to be common to the cranium and face are five, *viz.* the ethmoidal, sphenoidal, transverse, and two zygomatic.—Parts however of these sutures are at the junction of only the bones of the skull.

The ethmoidal and sphenoidal sutures surround the bones of these names; and in some places help to make up other sutures, particularly the squamous and transverse; and, in other parts, there is but one suture common to these two bones.

The transverse suture is extended quite cross the face, from the external canthus of one orbit, to the same place of the other.

The zygomatic sutures are one on each side, being short, and slanting from above obliquely, downwards and backwards; to join a process of the cheek-bone to one of

the temporal bones, which advances towards the face; so that the two processes thus united, form a sort of bridge or jugum, under which the temporal muscle passes; on which account the processes, and sutures joining them, have been called *zygomatic*.

The advantages of the sutures of the cranium are these: 1. That this capsula is more easily formed and extended into a spherical figure, than if it had been one continued bone. 2. That the bones which are at some distance from each other at birth might then yield, and allow to the head a change of shape, accommodated to the passage it is engaged in. Whence, in hard labour of child-bed, the bones of the cranium, instead of being only brought into contact, are sometimes made to mount one upon the other. 3. That the dura mater may be more firmly supported by its processes, which insinuate themselves into this conjunction of the bones; for doing this equally, and where the greatest necessity of adhesion is, the sutures are disposed at nearly equal distances, and the large reservoirs of blood, the sinuses, are under or near them. 4. That fractures might be prevented from reaching so far as they would in a continued bony substance. 5. That the connection at the sutures being capable of yielding, the bones might be allowed to separate; which has given great relief to patients from the violent symptoms which they had before this separation happened.

Having gone through the general structure of the cranium, we now proceed to examine each bone of which that brain-case consists.

The Os FRONTIS has its name from its being the only bone of that part of the face we call the forehead, though it reaches a good deal further. It has some resemblance in shape to the shell of the concha bivalvis, commonly called the *cockle*; for the greatest part of it is convex externally, and concave internally, with a serrated circular edge; while the smaller part has processes and depressions, which make it of an irregular figure.

The external surface of the os frontis is smooth at its upper convex part; but several processes and cavities are observable below: for, at each angle of each orbit, the bone juts out to form four processes, two internal, and as many external; which, from this situation, may well enough be named *angular*. Between the internal and external angular processes of each side, an arched ridge is extended, on which the eye-brows are placed.—Very little above the internal end of each of these superciliary ridges, a protuberance may be remarked, in most skulls, where there are large cavities, called *sinuses*, within the bone.—Betwixt the internal angular processes, a small process rises, which forms some share of the nose, and thence is named *nasal*.—Some observe a protuberant part on the edge of the bone, behind each external angular process, which they call *temporal* processes; but these are inconsiderable.—From the under part of the superciliary ridges, the frontal bone runs a great way backwards; which parts may justly enough be called *orbital* processes. These, contrary to the rest of this bone, are concave externally, for receiving the globes of the eyes, with their muscles, fat, &c.

In each of the orbital processes, behind the middle of the superciliary ridges, a considerable sinuosity is observed,

where



where the *glandula innominata Galeni*, or *lachrymalis*, is lodged.—Behind each internal angular process, a small pit may be remarked, where the cartilaginous pulley of the *musculus obliquus major* of the eye is fixed.—Betwixt the two orbital processes, there is a large discontinuation of the bone, into which the cribriform part of the *os ethmoides* is incased.—The frontal bone frequently has little caverns formed in it here where it is joined to the ethmoid bone.—Behind each external angular process, the surface of the frontal bone is considerably depressed where part of the temporal muscle is placed.

The *foramina*, or holes, observable on the external surface of the frontal bone, are three in each side.—One in each superciliary ridge; a little removed from its middle towards the nose; through which a twig of the ophthalmic branch of the fifth pair of nerves passes out of the orbit, with a small artery, from the internal carotid, to be distributed to the teguments and muscles of the forehead.—These vessels in some skulls make furrows in the *os frontis*, especially in the bones of children; and therefore we ought to beware of transverse incisions on either side of the *os frontis*, which might either open these vessels or hurt the nerves, while they are yet in part within the bone; for, when vessels are thus wounded, it is difficult to stop the hæmorrhagy, because the adhesion of a part of the artery to the bone hinders its contraction, and consequently styptics can have little effect; the sides of the furrow keep off compressing substances from the artery; and we would wish to shun cauteries or escharotics, because they make the bone carious; and nerves, when thus hurt, sometimes produce violent symptoms.—But we must remark, that often, instead of a hole, a notch only is to be seen: Nay, in some skulls, scarce a vestige even of this is left; in others, both hole and notch are observable, when the nerve and artery run separately. Frequently a hole is found on one side, and a notch on the other; at other times we see two holes; or there is a common hole without, and two distinct entries internally. Near the middle of the inside of each orbit, hard by, or in the transverse suture, there is a small hole for the passage of the nasal twig of the first branch of the fifth pair of nerves, and of a branch of the ophthalmic artery. This hole is sometimes entirely formed in the *os frontis*; in other skulls, the sides of it are composed of this last bone, and of the *os planum*. It is commonly known by the name of *orbitarium internum*, though *anterior* should be added, because of the next, which is commonly omitted.

—This, which may be called *orbitarium internum posterius*, is such another as the former; only smaller, and about an inch deeper in the orbit: through it a small branch of the ocular artery passes to the nose.—Besides these six, there are a great number of small holes observable on the outer surface of this bone, particularly in the two protuberances above the eye-brows. Most of these penetrate no further than the sinuses, or than the diploe, if the sinuses are wanting. The place, size, and number of them, are however uncertain: They generally serve for the transmission of small arteries or nerves.

The internal surface of the *os frontis* is concave, except at the orbital processes, which are convex, to sup-

port the anterior lobes of the brain. This surface is not so smooth as the external; for the larger branches of the arteries of the *dura mater* make some furrows in its sides and back-parts. The sinosities from the luxuriant risings of the brain, mentioned when describing the general structure of the cranium, are often very observable on its upper part; and its lower and fore parts are marked with the contortions of the anterior lobes of the brain.—Through the middle of this internal surface, where always in children, and sometimes in old people, the bone is divided, either a ridge stands out, to which the upper edge of the *falx* is fastened, or a furrow runs, in which the upper side of the superior longitudinal sinus is lodged; on both these accounts chyrurgical authors justly discharge the application of the *trepan* here.

Immediately at the root of this ridge or furrow there is a small hole, which sometimes pierces through the first table, and, in other skulls, opens into the superior sinus of the ethmoid bone within the nose. In it a little process of the *falx* is lodged, and a small artery, and sometimes a vein, runs; and the superior longitudinal sinus begins here.—This hole, however, is often not entirely proper to the *os frontis*; for in several skulls, the lower part of it is formed in the upper part of the base of the *crista galli*, which is a process of the ethmoid bone.

The *os frontis* is composed of two tables, and an intermediate diploe, as the other bones of the cranium are, and in a middle degree of thickness between the *os occipitis* and the parietal bones.

The diploe is also exhausted in that part above the eye-brows, where the two tables of the bone separate, by the external being protruded outwards, to form two large cavities, called *sinus frontales*.—These are divided by a middle perpendicular bony partition.—In some skulls, besides the large perpendicular septum, there are several bony pillars, or short partitions, found in each sinus; in others these are wanting.—For the most part the septum is entire; at other times it is discontinued, and the two sinuses communicate.—Each sinus commonly opens by a roundish small hole, at the inner and lower part of the internal angular processes, into a sinus formed in the nose, at the upper and back part of the *os unguis*; near to which there are also some other small sinuses of this bone, the greater part of which open separately nearer the septum narium, and often they terminate in the same common canal with the large ones.

In a natural and sound state, these cavities are of considerable advantage; for the organ of smelling being thus enlarged, the effluvia of odorous bodies more difficultly escape it; and their impressions being more numerous, are therefore stronger, and affect the organ more.—These and the other cavities which open into the nose, increase the sound of our voice, and render it more melodious, by serving as so many vaults to rebound the notes. Hence people labouring under a coryza, or stoppage of the nose from any other cause, when they are by the vulgar, though falsely, said to speak through their nose, have such a disagreeable harsh voice.—The liquor separated in the membrane of these sinuses, drills down upon the membrane of the nose to keep it moist.

From the description of these sinuses, it is evident,

how useless, nay, how pernicious it must be, to apply a trepan on this part of the skull; for this instrument, instead of piercing into the cavity of the cranium, would reach no further than the sinuses.

The upper circular part of the *os frontis* is joined to the *ossa parietalia*, from one temple to the other, by the coronal suture. From the termination of the coronal suture to the external-angular processes, this bone is connected to the sphenoid by the sphenoidal suture. At the external canthi of the eyes, its angular processes are joined by the transverse suture to the *ossa malarum*, to which it adheres one third down the outside of the orbits; whence to the bottom of these cavities, and a little up on their internal sides, these orbital processes are connected to the sphenoidal bone by that same suture.—On the inside of each orbit, the orbital process is indented between the cribriform part of the ethmoid bone, and the *os plantum* and *unguis*.—The transverse suture afterwards joins the frontal bone to the superior nasal processes of the *ossa maxillaria superiora*, and to the nasal bones. And, lastly, its nasal process is connected to the nasal lamella of the ethmoid bone.

The frontal bone serves to defend and support the anterior lobes of the brain. It forms a considerable part of the cavities that contain the globes of the eyes, helps to make up the *septum narium*, organ of smelling, &c. From the description of the several parts, the other uses of this bone are evident.

In a ripe child, the frontal bone is divided through the middle; the superciliary holes are not formed; often a small round piece of each orbital process, behind the superciliary ridge, is not ossified, and there is no sinus to be seen within its substance.

Each of the two *OSSA PARIETALIA*, or bones serving as walls to the *encephalon*, is an irregular square; its upper and fore sides being longer than the one behind or below. The inferior side is a concave arch; the middle part receiving the upper round part of the temporal bone.—The angle formed by this upper side and the fore one, is so extended, as to have the appearance of a process.

The external surface of each *os parietale* is convex. Upon it, somewhat below the middle height of the bone, there is a transverse arched ridge, of a whiter colour generally than any other part of the bone; from which, in bones that have strong prints of muscles, we see a great many converging furrows, like so many radii drawn from a circumference towards a centre. From this ridge of each bone the temporal muscle rises; and, by the pressure of its fibres, occasions the furrows just now mentioned.—Below these, we observe, near the semicircular edges, a great many risings and depressions, which are joined to like inequalities on the inside of the temporal bone, to form the squamous suture. The temporal bone may therefore serve here as a buttress, to prevent the lower side of the parietal from starting upwards when its upper part is pressed or struck.

Near the upper sides of these bones, towards the hind part, is a small hole in each, through which a vein passes from the teguments of the head to the longitudinal sinus.—In several skulls, one of the *ossa parietalia* has not this

hole; in others, there are two in one bone; and in some not one in either. Most frequently this hole is through both tables; at other times the external table is only perforated.—The knowledge of the course of these vessels may be of use to surgeons, when they make any incision near this part of the head, lest, if the vessels are rashly cut near the hole, they shrink within the substance of the bone, and so cause an obstinate hæmorrhagy, which neither ligatures nor medicines can stop.

On the inner concave surface of the parietal bones, we see a great many deep furrows, disposed somewhat like the branches of trees: The furrows are largest and deepest at the lower edge of each *os parietale*, especially near its anterior angle, where sometimes a full canal is formed. They afterwards divide into small furrows, in their progress upwards.—In some skulls a large furrow begins at the hole near the upper edge, and divides into branches, which join with those which come upwards, shewing the communications of the upper and lower vessels of the *dura mater*.—In these furrows we frequently see passages into the diploe. On the inside of the upper edge of the *ossa parietalia*, there is a large sinuosity, frequently larger in the bone of one side than of the other, where the upper part of the *falx* is fastened, and the superior longitudinal sinus is lodged.—Generally part of the lateral sinuses makes a depression near the angle, formed by the lower and posterior sides of these bones; and the pits made by the prominent parts of the brain are to be seen in no part of the skull more frequent, or more considerable, than in the internal surface of the parietal bones.

The *ossa parietalia* are amongst the thinnest bones of the cranium; but enjoy the general structure of two tables and diploe the completest, and are the most equal and smooth.

These bones are joined at their fore-side to the *os frontis* by the coronal suture; at their long inferior angles, to the sphenoid bone, by part of the suture of this name; at their lower edge, to the *ossa temporum*, by the squamous suture, and its posterior additamentum; behind, to the *os occipitis*, or *ossa triquetra*, by the lambdoid suture; and above, to one another, by the sagittal suture.

In a child born at the full time, none of the sides of this bone are completed; and there never is a hole in the ossified part of it near to the sagittal suture.

The large unossified ligamentous part of the cranium observable between the parietal bones, and the middle of the divided *os frontis* of new-born children, called by the vulgar the *open of the head*, was imagined by the ancients to serve for the evacuation of the superfluous moisture of the brain; and therefore they named it *bregma*, or the fountain; sometimes adding the epithet *pulsatilis*, or beating, on account of the pulsation of the brain felt through this flexible ligamento-cartilaginous substance. Hence very frequently the parietal bones are called *ossa bregmatica*.

All the *bregma* is generally ossified before seven years of age. Several authors say, they have observed it unossified in adults; and physicians, who order the application of medicines at the meeting of the coronal and sagittal

tal futures, seem yet to think that a derivation of noxious humours from the encephalon is more easily procured at this part than any other of the skull; and that medicines have a greater effect here, than elsewhere, in the internal disorders of the head.

*OSSE TEMPORUM*, so named, say authors, from the hair's first becoming grey on the temples, and thus discovering peoples ages, are each of them equal and smooth above, with a very thin semicircular edge; which, from the manner of its connection with the neighbouring bones, is distinguished by the name of *os squamosum*.—Behind this, the upper part of the temporal bone is thicker, and more unequal, and is sometimes described as a distinct part, under the name of *pars mammillaris*.—Towards the base of the skull, the temporal bone appears very irregular and unequal; and this part, instead of being broad, and placed perpendicularly, as the others are, is contracted into an oblong very hard substance, extended horizontally forwards and inwards, which in its progress becomes smaller, and is commonly called *os petrosum*.

Three external processes of each temporal bone are generally described.—The *first*, placed at the lower and hind-part of the bone, from its resemblance to a nipple, is called *mastoides*, or *mammillaris*. It is not solid, but within is composed of cancelli, or small cells, which have a communication with the large cavity of the ear, the drum; and therefore sounds, being multiplied in this vaulted labyrinth, are increased, before they are applied to the immediate organ of hearing. Into the mastoid process, the sterno-mastoideus muscle is inserted; and to its back-part, where the surface is rough, the trachelo-mastoideus, and part of the splenius are fixed.—About an inch farther forward, the *second* process begins to rise out from the bone; and having its origin continued obliquely downwards and forwards for some way, it becomes smaller, and is stretched forwards to join with the *os male*; they together forming the bony jugum, under which the temporal muscle passes. Hence this process has been named *zygomatic*. Its upper edge has the strong aponeurosis of the temporal muscle fixed into it; and its lower part gives rise to a share of the masseter.—The fore-part of the base of this process is an oblong tubercle, which in a recent subject is covered with a smooth polished cartilage, continued from that which lines the cavity immediately behind this tubercle.—From the under craggy part of the *os temporum*, the *third* process stands out obliquely forwards. The shape of it is generally said to resemble the ancient stylus scriptorius; and therefore it is called the *styloid* process. Several muscles have their origin from this process, and borrow one half of their name from it; as *stylo-glossus*, *stylo-hyoideus*, *stylo-pharyngeus*: to it a ligament of the *os hyoides* is sometimes fixed; and another is extended from it to the inside of the angle of the lower jaw. This process is often, even in adults, not entirely ossified, but is ligamentous at its root, and sometimes is composed of two or three distinct pieces.—Round the root of it, especially at the fore-part, there is a remarkable rising of the *os petrosum*, which some have esteemed a process; and, from the appearance it makes with the styloid, have named it *vaginialis*.—Others again have, under

the name of *auditory* process, reckoned among the external processes that semicircular ridge, which, running between the root of the mastoid and zygomatic processes, forms the under part of the external meatus auditorius.

The sinuosities or depressions on the external surface of each *os temporum* are these:—A long fossa at the inner and back part of the root of the mammary process, where the posterior head of the digastric muscle has its origin.—Immediately before the root of the zygomatic process, a considerable hollow is left, for lodging the crotaphite muscle.—Between the zygomatic, auditory, and vaginal processes, a large cavity is formed; through the middle of which, from top to bottom, a fissure is observable, into which part of the ligament that secures the articulation of the lower jaw with this bone is fixed. The fore-part of the cavity being lined with the same cartilage which covers the tubercle before it, receives the condyle of the jaw; and in the back-part a small share of the parotid gland, and a cellular fatty substance, are lodged.—At the inside of the root of the styloid apophyse, there is a thimble-like cavity, where the beginning of the internal jugular vein, or end of the lateral sinus, is lodged.—Round the external meatus auditorius, several sinuosities are formed for receiving the cartilages and ligaments of the ear, and for their firm adhesion.

The holes that commonly appear on the outside of each of these bones, and are proper to each of them, are five.—The *first*, situated between the zygomatic and mastoid processes, is the orifice of a large funnel-like canal, which leads to the organ of hearing; therefore is called *meatus auditorius externus*.—The *second* gives passage to the portia dura of the seventh pair of nerves; and, from its situation between the mastoid and styloid processes, is called *foramen stylo-mastoideum*.—Some way before, and to the inside of the styloid process, is the *third* hole; the canal from which runs first upwards, then forwards, and receives into it the internal carotid artery, and the beginning of the intercostal nerve; where this canal is about to make the turn forwards, one, or sometimes two very small holes go off towards the cavity of the ear called *tympanum*: through these Valsalva affirms the proper artery or arteries of that cavity are sent.—On the anterior edge of this bone, near the former, a *fourth* hole is observable, being the orifice of a canal which runs outwards and backwards, in a horizontal direction, till it terminates in the tympanum. This, in the recent subject, is continued forward and inward, from the parts which were mentioned just now as its orifice in the skeleton, to the side of the nostrils: being partly cartilaginous, and partly ligamentous. The whole canal is named, *Itra a palato ad aurem*, or *Eustachian tube*.—On the external side of the bony part of this canal, and a-top of the chink in the cavity that receives the condyle of the lower jaw, is the course of the little nerve said commonly to be reflected from the lingual branch of the fifth pair, till it enters the tympanum, to run across this cavity, and to have the name of *chorda tympani*.—The *fifth* hole is very uncertain, appearing sometimes behind the mastoid process; sometimes it is common to the temporal and occipital bones; and in several skulls there

is no such hole. The use of it, when found, is for the transmission of a vein from the external teguments to the lateral sinus: But, in some subjects, a branch of the occipital artery passes through this hole, to serve the back-part of the dura mater.

The internal surface of the ossa temporum is unequal; the upper circular edge of the squamous part having numerous small ridges and furrows for its conjunction with the parietal bones; and the rest of it is irregularly marked with the convolutions of the middle part of the brain, and with furrows made by the branches of the arteries of the dura mater.

From the under part of this internal surface, a larger transverse, hard, craggy protuberance runs horizontally inwards and forwards, with a sharp edge above, and two flat sides, one facing obliquely forwards and outwards, and the other as much backwards and inwards. To the ridge between these two sides, the large lateral process of the dura mater is fixed.

Sometimes a small bone, akin to the sesamoid, is found between the small end of this petrous process and the sphenoid bone.

Towards the back-part of the inside of the os temporum, a large deep fossa is conspicuous, where the lateral sinus lies; and frequently on the top of the petrous ridge, a furrow may be observed, where a small sinus is situated.

The internal proper foramina of each of these bones are, first, the internal meatus auditorius in the posterior plain side of the petrous process. This hole soon divides into two; one of which is the beginning of the aquæduct of Fallopius: the other ends in several very small canals, that allow a passage to the branches of the portio mollis of the seventh pair of nerves, into the vestibule and cochlea. Through it also an artery is sent, to be distributed to the organ of hearing.—The second hole, which is on the anterior plain side of the craggy process, gives passage to a reflected branch of the second branch of the fifth pair of nerves, which joins the portio dura of the auditory nerve, while it is in the aquæduct, small branches of blood-vessels accompanying the nerves, or passing through smaller holes near this one.—The passage of the cutaneous vein into the lateral sinus, or of a branch of the occipital artery, is seen about the middle of the large fossa for that sinus; and the orifice of the canal of the carotid artery is evident at the under part of the point of the petrous process.

The upper round part of the squamous bones is thin, but equal; while the low petrous part is thick and strong, but irregular and unequal, having the distinction of tables and diploe confounded, with several cavities, processes, and bones within its substance, which are parts of the organ of hearing. See the description of the bones, muscles, &c. of the ear, in part VI.

The temporal bones are joined above to the parietal bones by the squamous-futures, and their posterior adductamenta: Before, to the sphenoid bone by the future of that name; to the cheek-bones by the zygomatic futures: Behind, to the occipital bone, by the lambdoid future and its adductamenta; and they are articulated with the

lower jaw in the manner which shall be described when this bone is examined.

Os OCCIPITIS, so called from its situation, is convex on the outside, and concave internally. Its figure is an irregular square, or rather rhomboid; of which the angle above is generally a little rounded; the two lateral angles are more finished, but obtuse; and the lower one is stretched forward in form of a wedge, and thence is called by some the *cuneiform process*.

The external surface is convex, except at the cuneiform apophyse, where it is flatted. At the base of this triangular process, on each side of the great hole, but more advanced forwards than the middle of it, the large oblong protuberances, named the *condyles*, appear, to serve for the articulation of this bone with the first vertebra of the neck. The smooth surface of each of these condyloid processes is longest from behind forwards, where, by their oblique situation, they come much nearer to each other than they are at their back-part. Their inner sides are lower than the external, by which they are prevented from sliding to either side out of the cavities of the first vertebra.—Round their root a small depression and spongy roughness is observable, where the ligaments for surrounding and securing their articulations adhere.—Though the motion of the head is performed on the condyles, yet the centre of gravity of that globe does not fall between them, but is a good way further forward; from which mechanism it is evident, that the muscles which pull the head back must be in a constant state of contraction: which is stronger than the natural contraction of the proper flexors, else the head would always fall forwards, as it does when a man is asleep, or labours under a palsy, as well as in infants, where the weight of the head far exceeds the proportional strength of these muscles.

All round the great foramen the edges are unequal, for the firmer adhesion of the strong circular ligament which goes thence to the first vertebra.—One end of each lateral or moderator ligament of the head, is fixed to a rough surface at the fore-part of each condyle, and the perpendicular one is connected to a rough part of the edge of the great hole between the two condyles.

On the inner surface of the os occipitis we see two ridges; one standing perpendicular, the other running horizontally across the first. The upper part of the perpendicular limb of the cross, to which the falx is fixed, is hollowed in the middle, or often on one side, for the reception of the superior longitudinal sinus, and the lower part of it has the small or third process of the dura mater fastened to it, and is sometimes hollowed by the occipital sinus. Each side of the horizontal limb is made hollow by the lateral sinuses inclosed in the transverse process of the dura mater; the fossa in the right side being generally a continuation of the one made by the longitudinal sinus in the perpendicular limb, and therefore is larger than the left one.—Round the middle of the cross there are four large depressions separated by its limbs; the two upper ones being formed by the back-part of the brain, and the two lower ones by the cerebellum.—Farther forward than the last mentioned depressions,

processes, is the lower part of the fossa for the lateral sinus on each side.—The inner surface of the cuneiform apophyse is made concave for the reception of the medulla oblongata, and of the basilar artery.—A furrow is made on each side, near the edges of this process, by a sinus of the dura mater, which empties itself into the lateral sinus.

The holes of this bone are commonly five proper, and two common to it and to the temporal bones.—The first of the proper holes, called *foramen magnum*, from its size, is immediately behind the wedge-like process, and allows a passage to the medulla oblongata, *nervi accessorii*, to the vertebral arteries, and sometimes to the vertebral veins.—At each side of this great hole, near its fore-part, and immediately above the condyles, we always find a hole, sometimes two, which soon unite again into one that opens externally; through these the ninth pair of nerves go out of the skull.—The fourth and fifth holes pierce from behind the condyle of each side, into the fossae of the lateral sinuses; they serve for the passage of the cervical veins to these sinuses. Often one of these holes is wanting, sometimes both, when the veins pass through the great foramen.—Besides these five, we frequently meet with other holes near the edges of this bone, for the transmission of veins; but their number and diameter are very uncertain. The two common foramina are the large irregular holes, one in each side, between the sides of the cuneiform process, and the edges of the petrous bones. In a recent subject, a strong membrane runs cross from one side to the other of each of these holes.

The occipital bone is among the thickest of the cranium, though unequally so; for it is stronger above, where it has no other defence than the common teguments, than it is below, where, being pressed by the lobes of the brain and cerebellum on one side, and by the action of the muscles on the other, it is so very thin, as to be diaphanous in many skulls.

The occipital bone is joined above to the ossa parietalia and triquetra when present, by the lambdoid suture;—laterally to the temporal bones, by the additamenta of the lambdoid suture;—below to the sphenoid bone, by the end of its cuneiform process, in the same way that epiphyses and their bones are joined.—The os occipitis is joined by a double articulation to the first vertebra of the neck, each condyle being received into a superior oblique process of that vertebra.

Os ETHMOIDES, or the sieve-like bone, has got its name from the great number of small holes with which that part of it first taken notice of is pierced. When this bone is entire, the figure of it is not easily described; but, by a detail of its several parts, some idea may be afforded of the whole; and therefore we shall distinguish it into the cribriform lamella with its process, the nasal lamella, cellule, and ossa spongiosa.

The thin horizontal lamella, is all (except its back-part) pierced obliquely by a great number of small holes, through which the filaments of the olfactory nerves pass.—From the middle of the internal side of this plate, a thick process rises upwards, and, being highest at the fore-part, gradually becomes lower, as it is extended

backwards. From some resemblance which this process was imagined to have to a cock's comb, it has been called *crista galli*. The falx is connected to its ridge, and to the unperforated part of the cribriform plate.—When the crista is broke, its base is sometimes found to be hollow, with its cavity opening into the nose.

From the middle of the outer surface of the cribriform lamella, a thin solid plate is extended downwards and forwards, having the same common base with the crista galli. Generally it is not exactly perpendicular, but is inclined to one side or other, and therefore divides the cavity of the nose unequally. Its inclination to one side, and flexure in the middle, is sometimes so great, that it fills up a large share of one of the nostrils, and has been mistook for a polypus there.—It is thin at its rise, and rather still thinner in its middle; yet afterwards, towards its lower edge, it becomes thicker, that its conjunction with the bones and middle cartilage of the nose might be firmer.

At a little distance from each side of this external process, a cellular and spongy bony substance depends from the cribriform plate. The number and figure of the cells in this irregular process of each side, are very uncertain; only the cells open into each other, and into the cavity of the nose: The uppermost, which are below the aperture of the frontal sinuses, are formed like funnels.—The outer surface of those cells is smooth and plain, where this bone assists in composing the orbit; at which place, on each side, it has got the name of *os planum*; on the upper edge of which, a small notch or two may sometimes be observed, which go to the formation of the internal orbital holes.

Below the cells of each side, a thin plate is extended inwards, and then bending down, it becomes thick, and of a spongy texture.—This spongy part is triangular, with a straight upper edge placed horizontally, an anterior one slanting from above, downwards and forwards, and with a pendulous convex one below.—The upper and lower edges terminate in a sharp point behind.—The side of this pendulous spongy part next to the septum narium is convex, and its external side is concave.—These two processes of the ethmoid bone have got the name of *ossa spongiosa*, or *turbinata superiora*, from their substance, figure, and situation.

All the prominencies, cavities and meanders of this ethmoid bone, are covered with a continuation of the membrane of the nostrils, in a recent subject.—Its horizontal cribriform plate is lodged between the orbital processes of the frontal bone, to which it is joined by the ethmoid suture, except at the back-part, where it is connected with the cuneiform bone, by a suture common to both these bones.—Where the ossa plana are contiguous to the frontal bone within the orbit, their conjunction is reckoned part of the transverse suture.—Farther forward than the ossa plana, the cells are covered by the ossa unguis, which are not only contiguous to these cells, but cannot be separated from them, without breaking the bony substance.—Below the ossa unguis and plana, these cells and ossa spongiosa are overlopped by the maxillary bones.—The cellular part of each palate-bone is contiguous to each os planum and cells backwards.—The

lower edge of the nasal perpendicular plate is received into the furrow of the vomer.—Its posterior edge is joined to the fore-part of the processus azygos of the sphenoid bone.—Its upper edge joins the nasal process of the frontal and nasal bones, and its anterior one is connected to the middle cartilage of the nose.

From all which the uses of this bone are evident, *viz.* to sustain the anterior lobes of the brain; to give passage to the olfactory nerves, and attachment to the falx; to enlarge the organ of smelling, by allowing the membrane of the nose a great extent; to straiten the passage of the air through the nose, by leaving only a narrow winding canal, on the sensible membranous sides of which the substances conveyed along with the air must strike, to form part of the orbit of the eyes and septum narium; while all its parts are so light as not to be in hazard of separating by their weight; and they are so thin, as to form a large surface, without occupying much space.

OS SPHENOIDES, or wedge-like bone, so called because of its situation in the middle of the bones of the cranium and face, is of an irregular figure, and bears some faint resemblance to a bat with its wings extended:

When we view the external surface of the os sphenoides, two or three remarkable processes from each side of it may be observed; which are all of them again subdivided.—The first pair is the two large lateral processes or wings; the upper part of each of which is called the *temporal process*, because they join with the temporal bones in forming the temples, and the seat for some share of the crotaphite muscles. That part of the wings which juts out towards the inside, somewhat lower than the temporal apophyses, and is smooth and hollowed, where it makes up part of the orbit, is thence named *orbital process*. Behind the edge separating these two processes, there is often a small groove, made by a branch of the superior maxillary nerve, in its passage to the temporal muscle. The lowest and back-part of each wing, which runs out sharp to meet the ossa petrosa, has been styled the *spinous process*: from near the point of which a sharp pointed process is frequently produced downwards, which some call *styiform*, that affords origin to the ptery-staphylinus externus muscle. From this styloid process a very small groove is extended along the edge of the bone to the hollow at the root of the internal plate of the following processes, which forms part of the Eustachian tube.—The second pair of external processes of the cuneiform bone is the two which stand out almost perpendicular to the base of the skull. Each of them has two plates, and a middle fossa facing backwards, and are named *pterygoid* or *aliform* processes. The external plates are broadest, and the internal are longest. From each side of the external plates, the pterygoid muscles take their rise. At the root of each internal plate, a small hollow may be remarked, where the musculus ptery-staphylinus internus, or circumflexus palati, rises, and some share of the cartilaginous end of the Eustachian tube rests; and, at the lower end of the same plate, is a hook-like rising or process, round which the tendon of the last named muscle plays, as on a pulley.—To these another pair may be added, to wit, the little triangular thin process, which comes from each side

of the body of the sphenoid bone, where the pterygoid processes are rising from it, and are extended over the lower part of the aperture of the sinus, as far as to join the ethmoid bone, while their body hangs down into the nares.—Besides these pairs of processes, there is a sharp ridge which stands out from the middle of its base: Because it wants a fellow, it may be called *processus azygos*. The lower part of this process, where it is received into the vomer, is thick, and often not quite perpendicular, but inclining more to one side than the other. The fore-part of this process, where it joins the nasal plate of the os ethmoides, is thin and straight.

The depressions, sinuosities, and fossæ, on the external surface of this sphenoid bone, may be reckoned up to a great number, *viz.* two on the temporal apophyses where the crotaphite muscles lodge.—Two on the orbital processes, to make way for the globes of the eyes.—Two between the temporal and spinous processes, for receiving the temporal bones.—Two between the plates of the pterygoid processes, where the muscoli pterygoidei interni and ptery-staphylini interni are placed.—Two between the pterygoid and orbital processes, for forming the holes common to this and to the cheek and maxillary bones.—Two on the lower ends of the aliform processes, which the palate-bones enter into.—Two at the roots of the temporal and pterygoid processes, where the largest share of the external pterygoid muscles have their rise.—Two at the sides of the processus azygos, for forming part of the nose, &c.

What was described under the name of *temporal and spinous process* on the outside of the skull, are likewise seen on its inside, where they are concave, for receiving part of the brain; and commonly three apophyses on the internal surface of the sphenoid bone are only mentioned.—Two rising broad from the fore-part of its body, become smaller, as they are extended obliquely backwards.—The third standing on a long transverse base, near the back-part of the body of this bone, rises nearly erect, and of an equal breadth, terminating often in a little knob on each side. The three are called *clinoid*, from some resemblance which they were thought to have to the supporters of a bed.—From the roots of the anterior clinoid processes, the bone is extended on each side outwards and forwards, till it ends in a sharp point, which may have the name of the *transverse spinous process*.—Between, but a little farther back than the two anterior clinoid processes, we see a protuberance considerably smaller than the posterior clinoid process, but of its shape.—Another process from between the transverse processes, often forces itself forwards into the os ethmoides.

Within the skull, there are two sinuosities in the internal part of each wing of the sphenoid bone, for receiving the middle part of the brain.—One between the transverse spinous processes, for lodging the part of the brain where the crura medullæ oblongatæ are.—Immediately before the third or middle clinoid process, a single pit generally may be remarked, from which a fossa goes out on each side to the holes through which the optic nerves pass. The pit is formed by the conjoined optic nerves; and in the fossæ these nerves are lodged, as they

they run divided within the skull.—Between that third protuberance and the posterior clinoid process, the larger pit for the glandula pituitaria may be remarked. This cavity, because of its resemblance to a Turkish saddle, is always described under the name of *fella Turcica*, or *ephippium*.—On the sides of the posterior clinoid process a fossa may be remarked, that stretches upwards, then is continued forwards along the sides of the *fella Turcica*, near to the anterior clinoid processes, where a pit on each side is made. These fossæ point out the course of the two internal carotid arteries, after they have entered the skull.

The holes on each side of the *os sphenoides* are six proper, and three common.—The *first* is the round one immediately below the anterior clinoid processes, for the passage of the optic nerve, and of the branch of the internal carotid artery that is sent to the eye.—The *second* is the *foramen lacerum*, or large slit between the transverse spinous and orbital processes: Through it the third, fourth, the first branch of the fifth, and the greater share of the sixth pair of nerves, and an artery from the internal carotid, go into the orbit. Sometimes a small branch of the external carotid enters near its end, to be distributed to the dura mater, and a vein, some call it the *venous duct*, or *Nuck's aqueduct*, returns through it to the cavernous sinus.—The *third* hole, situated a little below the one just now described, is called *rotundum*, from its shape. It allows passage to the second branch of the fifth pair of nerves, or superior maxillary nerve, into the bottom of the orbit.—The *fourth* is the *foramen ovale*, about half an inch behind the round hole. Through it the third branch of the fifth pair, or inferior maxillary nerve, goes out; and sometimes a vein from the dura mater passes out here.—Very near the point of the spinous process is the *fifth* hole of this bone: It is small and round, for a passage to the largest artery of the dura mater, which often is accompanied with a vein.—The *sixth* proper hole cannot be well seen, till the cuneiform bone is separated from all the other bones of the cranium; for one end of it is hid by a small protuberance of the internal plate of the pterygoid process, and by the point of the processus petrosus of the temporal bone. Its canal is extended above the inner plate of the pterygoid process; and where it opens into the cavity of the nose, it is concealed by the thin laminous part of the palate-bone. Through it a considerable branch of the second branch of the fifth pair of nerves is reflected.—Often in the middle of the *fella Turcica*, a small hole or two pierce as far as the cellular substance of the bone; and sometimes at the sides of this *fella*, one or more small holes penetrate into the sphenoidal sinuses.

The *first* of the common holes is that unequal fissure at the side of the *fella Turcica*, between the extreme point of the *os petrosum* and the spinous process of the cuneiform bone.—The *second* common hole is the large discontinuation of the external side of the orbit, left between the orbital processes of the cuneiform bone, the *os maxillare, male*, and *palati*. In this large hole the fat for lubricating the globe of the eye and temporal muscle is lodged, and branches of the superior maxillary nerve, with small arteries from the carotid and veins, pass.

—The *third* hole is formed between the base of this bone and the root of the orbital process of the palate-bone of each side. Through this a branch of the external carotid artery, and of the second branch of the fifth pair of nerves, are allowed a passage to the nostrils, and a returning vein accompanies them.

Under the *fella Turcica*, and some way farther forward, but within the substance of the sphenoid bone, are two sinuses, separated by a bony plate. Each of them is lined with a membrane, and opens into the upper and back part of each nostril by a round hole, which is at their upper fore-part. This hole is not formed only by the *os sphenoides*, which has an aperture near as large as any transverse section of the sinus, but also by the palate-bones which are applied to the fore-part of these sinuses, and close them up, that hole only excepted, which was already mentioned. Frequently the two sinuses are of unequal dimensions, and sometimes there is only one large cavity, with an opening into one nostril.

As this bone is extremely ragged and unequal, so its substance is of very different thickness, being in some places diaphanous; in others it is of a middle thickness, and its middle back-part surpasses the greatest share of the cranium in thickness.

The *os sphenoides* is joined, by its wings, to the parietal bones above, to the *os frontis* and *ossa malarum* before, to the temporal bones behind;—by the fore-part of its body and spinous processes, to the frontal and ethmoid bones;—by its back-part, behind the two sinuses, to the occipital, where it looks like a bone with the epiphyses taken off;—to the palate-bones, by the ends of the pterygoid processes, and still more by the fore-part of the internal plates of the pterygoid processes, and of the sinuses;—to the maxillary bones, by the fore-part of the external pterygoid plates;—to the vomer and nasal plate of the *os ethmoides*, by the processus azygos. All these conjunctions, except the last, which is a schindylesis, are said to be by the future proper to this bone; though it is at first sight evident, that several other sutures, as the transverse, ethmoidal, &c. are confounded with it.

We see now how this bone is joined to all the bones of the cranium, and to most of the upper jaw; and therefore obtained the name of the *wedge-like bone*.

The *FACE* is the irregular pile of bones, composing the fore and under part of the head, which is divided into the upper and lower maxillæ or jaws.

The *superior maxilla* is the common designation given to the upper immoveable share of the face. The shape of the superior jaw cannot easily be expressed; nor is it necessary, provided the shape and situation of all the bones which compose it are described. It is bounded above by the transverse suture, behind by the fore-part of the sphenoid bone, and below by the mouth.

The upper jaw consists of six bones on each side, of a thirteenth bone which has no fellow, placed in the middle, and of sixteen teeth. The thirteen bones are, two *ossa nasi*, two *ossa unguis*, two *ossa malarum*, two *ossa maxillaria*, two *ossa palati*, two *ossa spongiosa inferiora*, and the vomer.

The

The *ossa nasi* are placed at the upper part of the nose;—the *ossa unguis* are at the internal canthi of the orbits;—*ossa malarum* form the prominence of the cheeks;—*ossa maxillaria* form the side of the nose, with the whole lower and fore part of the upper jaw, and the greatest share of the roof of the mouth;—*ossa palati* are situated at the back-part of the palate, nostrils, and orbit;—*ossa spongiosa* are seen in the lower part of the nares;—and the vomer helps to separate these two cavities.

The bones of the upper jaw are joined to the bones of the skull by the *schindylefis* and sutures already described as common to the cranium and face, and they are connected to each other by *gomphosis* and fifteen sutures.

The *gomphosis* only is where the teeth are fixed in their sockets, and the *schindylefis* is only where the edges of the vomer are joined to other bones.

The first is the *anterior nasal*, which is straight, and placed longitudinally in the middle fore-part of the nose.

The second and third are the *lateral nasal*, which are at each side of the nose, and almost parallel to the first future.

Each of the two lacrymal is almost semicircular, and is placed round the lacrymal groove.

The sixth and seventh are the *internal orbital*: each of which is extended obliquely from the middle of the lower side of an orbit to the edge of its base.

The two external orbitals are continued, each from the end of the internal orbital, to the under and fore-part of the cheek.

The tenth is the *maxillary*, which reaches only from the lower part of the septum narium to between the two middle dentes incisores.

The *longitudinal palate* future stretches from the middle of the foremost teeth through the middle of all the palate.

The *transverse palate* one runs across the palate, nearer the back than the fore-part of it.

Each of the two *palato-maxillary* is at the back-part of the side of each nostril.

The fifteenth is the *spinous*, which is in the middle of the lower part of the nostrils. This may perhaps be rather thought a double *schindylefis*.

These futures of the face have not such conspicuous indentations as those of the skull have.

*OSSA NASI*, so named from their situation at the root of the nose, are each of an irregular oblong square figure, being broadest at their lower end, narrowest a little higher than their middle; and becoming somewhat larger at the top, where they are ragged and thickest, and have a curvature forwards, that their connection with the frontal bone might be stronger.—These bones are convex externally, and thereby better resist any violence from without; and they are concave internally, for enlarging the cavity of the nose.

The lower edge of these bones is unequal, and is stretched outwards and backwards, to join the cartilages of the nostrils.—Their anterior side is thick, especially above, and unequal, that their conjunction to each other might be stronger; and a small rising may be remarked

on their inner edge, where they are sustained by the septum narium.—Their posterior side, at its upper half, has externally a depression, where it is overlapped some way by the maxillary bones, while its lower half covers these bones: By which contrivance, they do not yield easily to pressure applied to their fore-part or sides.

A small hole is frequently to be observed on their external surface, into which two, three, or four holes, which appear internally, terminate for the transmission of small veins; sometimes the holes go no further than the cancelli of the bones.

The nasal bones are firm and solid, with very few cells or cancelli in them.

They are joined above to the frontal bone, by the middle of the transverse suture;—behind, to the maxillary bones, by the lateral nasal sutures;—below, to the cartilages of the nose;—before to one another, by the anterior nasal future;—internally, to the septum narium.

These bones serve to cover and defend the root of the nose.

*OSSA UNGUIS*, or *LACRYMALIA*, are so named, because their figure and magnitude are something near to those of a nail of one's fingure, and because the tears pass upon them into the nose.

Their external surface is composed of two smooth concavities and a middle ridge.—The depression behind forms a small share of the orbit for the eye-ball to move on, and the one before is a deep perpendicular canal, or fossa, larger above than below, containing part of the lacrymal sac and duct. This is the part that ought to be pierced in the great operation for the fistula lacrymalis.—This fossa of the bone is cribriform, or has a great number of small holes through it, that the filaments from the membrane which lines it, insinuating themselves into these holes, might prevent a separation of the membrane, and secure the bone in its natural situation.—The ridge between these two cavities of the os unguis, is the proper boundary of the orbit at its internal canthus; and beyond which surgeons should not proceed backwards in performing operations here.—The internal or posterior surface of this bone consists of a furrow in the middle of two convexities.

The substance of the os unguis is as thin as paper, and very brittle; which is the reason that those bones are often wanting in skeletons, and need little force to pierce them in living subjects.

Each of these bones is joined, above, to the frontal bone, by part of the transverse future;—behind, to the os planum of the ethmoid bone, by the same future;—before, and below, to the maxillary bone, by the lacrymal future;—internally, the *ossa unguis* cover some of the sinus ethmoidales.

These unguiform bones compose the anterior internal parts of the orbits, lodge a share of the lacrymal sac and duct, and cover the ethmoid cells.—Their situation and tender substance make a rash operator in danger of destroying a considerable share of the organ of smelling, when he is performing the operation of the fistula lacrymalis.

*OSSA MALARUM* are the prominent square bones, which form the cheek on each side.—Before, their sur-

face



face is convex and smooth; backward, it is unequal and concave, for lodging part of the crotaphyte muscles.

The four angles of each of these bones have been reckoned processes by some.—The one at the external canthus of the orbit, called the *superior orbital* process, is the longest and thickest.—The second terminates near the middle of the lower edge of the orbit in a sharp point, and is named the *inferior orbital* process.—The third, placed near the lower part of the cheek, and thence called *maxillary*, is the shortest, and nearest to a right angle.—The fourth, which is called *zygomatic*, because it is extended backwards to the zygoma of the temporal bone, ends in a point, and has one side straight, and the other sloping.—Between the two orbital angles there is a concave arch, which makes about a third of the external circumference of the orbit, from which a fifth process is extended backwards within the orbit, to form near one third of that cavity; and hence it may be called the *internal orbital* process.—From the lower edge of each of the ossa malarum, which is between the maxillary and zygomatic processes, the *masseter* muscle takes its origin; and from the exterior part of the zygomatic process, the *musculus distortor oris* rises; in both which places the surface of the bone is rough.

On the external surface of each cheek bone, one or more small holes are commonly found, for the transmission of small nerves or blood-vessels from, and sometimes into the orbit.—On the internal surface are the holes for the passage of the nutritious vessels of these bones.—A notch on the outside of the internal orbital process of each of these bones assists to form the great slit common to this bone and to the sphenoid, maxillary, and palate-bones.

The substance of these bones is, in proportion to their bulk, thick, hard, and solid, with some cancelli.

Each of the ossa malarum is joined, by its superior and internal orbital processes, to the os frontis, and to the orbital process of the sphenoid bone, by the transverse suture.—By the edge between the internal and inferior orbital processes, to the maxillary bone, by the internal orbital suture.—By the side between the maxillary and inferior orbital process, again to the maxillary bone, by the external orbital suture.—By the zygomatic process, to the os temporum, by the zygomatic suture.

OSSA MAXILLARIA SUPERIORA, are the largest bones, and constitute the far greater part of the upper-jaw.

The processes of each os maxillare may be reckoned seven.—The first is the long nasal one at its upper and fore-part, which is broad below, and turns smaller, as it rises upwards, to make the side of the nose.—At the root of this, a transverse ridge may be observed within the nostrils, which supports the fore-part of the upper edge of the os spongiosum inferius.—The second is produced backwards and outwards, from the root of the nasal process, to form the lower side of the orbit; and therefore may be called *orbital*.—The edge of this orbital process, and the ridge of the nasal one, which is continued from it, make a considerable portion of the exter-

nal circumference of the orbit.—From the proper orbital process, a very rough triangular surface is extended downwards and outwards, to be connected to the cheek-bone; and therefore may be called the *malar* process, from the lowest protuberant part of which some share of the masseter muscle takes its rise.—Behind the orbital process, a large tuberosity or bulge of the bone appears, which is esteemed the fourth process.—On the internal part of this we often meet with a ridge, almost of the same height with that in the nasal process, which runs transversely, and is covered by a similar ridge of the palate-bone, on which the back-part of the upper edge of the os spongiosum inferius rests.—The convex back-part of this tuberosity is rough for the origin of part of the external pterygoid muscle, and more internally is scabrous, where the palate and sphenoid bones are joined to it.—That spongy protuberance at the lower circumference of this bone, where the sockets for the teeth are formed, is reckoned the fifth.—The sixth is the horizontal plate, which forms the greater part of the base of the nostrils, and roof of the mouth; its upper surface, which belongs to the nostrils, is very smooth, but the other below is arched and rough, for the stronger adhesion of the membrane of the mouth, which is stretched upon it, and in chewing, speaking, &c. might otherwise be liable to be separated.—The seventh rises like a spine from the inner edge of the last, and forms a small part of the partition of the nostrils.

The depressions in each maxillary bone are, 1. A sinusity behind the orbital process, made by the temporal muscle. 2. A pit immediately before the same process; where the origin of the musculus elevator labiorum communis, and elevator labii superioris, with a branch of the fifth pair of nerves, are lodged securely. 3. The hollow arch of the palate. 4. The semicircular great notch, or entry to the lower part of the nostrils, betwixt the root of the nasal process and spine of the palate-plate. 5. Sockets for the teeth: The number of these sockets is uncertain. 6. The lacrymal fossa in the nasal process, which assists the os unguis to form a passage for the lacrymal duct. Immediately on the outside of this, there is a small depression, from which the inferior or lesser oblique muscle of the eye has its origin. 7. The canal on the upper part of the great tuberosity within the orbit, which is almost a complete hole; in this a branch of the superior maxillary nerve passes.—Besides these, the superior surface of the great bulge is concave, to receive the under part of the eye.—Immediately above the transverse ridge in the nasal process, a small hollow is formed by the os spongiosum.

The holes of this bone are two proper and two common, which are always to be found, besides several others, whose magnitude, number, &c. are uncertain.—The first of the proper is the *external orbital*, immediately below the orbit, by which the infra-orbital branch of the second branch of the fifth pair of nerves, and a small artery, come out, after having passed in the canal, at the bottom of the orbit, described Numb. 7. of the depressions.—The second is the *foramen incisivum*, just behind the fore-teeth, which, at its under part, is one irregular hole common to both the maxillary bones when

they are joined; but, as it ascends, soon divides into two, three, or sometimes more holes; some of which open into each nostril. Through them small arteries and veins, and a twig of the second branch of the fifth pair of nerves pass, and make a communication between, or join the lining coats of the nose and mouth.

The first common hole is that which appears at the inner side of the back-part of the tuberosity and of the sockets of the teeth, and is formed by a fossa in this bone, and a corresponding one in the os palati; through it a nerve, which is a branch of the second branch of the fifth pair, runs to the palate.—The other common hole is the great slit in the outside of the orbit described already, as the second common hole of the sphenoid bone.

All the body of the maxillary bone is hollow, and leaves a large sinus akin to the frontal and sphenoid, which is commonly, but unjustly, called *antrum Highmorianum*.—At the bottom of this cavity, we may often observe some protuberances, in which the small points of the roots of the teeth are contained.—This cavern and the sockets of the teeth are often divided by the interposition only of a very thin bony plate, which is liable to be eroded by acrid matter collected in the antrum, or to be broke in drawing a tooth. The symptoms of a collection of a matter here naturally lead us to the practice of pulling out the teeth, and piercing through this plate into the antrum, to procure an evacuation of the collected matter.

The maxillary sinuses have the same uses as the frontal and sphenoidal; and the situation of the sinuses is such, that the liquor drilling from them, from the cells of the ethmoid and palate-bones, and from the lacrymal ducts, may always moisten all the parts of the membrane of the nares in the different situations which the head is in.

The substance of the ossa maxillaria is compact and firm, except at the inferior processes, in which the teeth are lodged, where it is very spongy.

The maxillary bones are joined above by the upper ends of their nasal processes to the os frontis, by the transverse suture;—at the sides of these processes, to the ossa unguis, by the lacrymal sutures;—to the nasal bones, by the lateral nasal sutures;—by their orbital processes, to the cheek-bones, by the external orbital sutures;—by the internal sides of the internal orbital processes, to the ossa plana, by part of the ethmoidal suture;—by the back-part of the tuberosities, to the palate bones, by the suturæ palato-maxillares;—by the posterior edges of their palatine lamellæ, to the ossa palati, by the transverse palate-suture;—by their nasal spines, to the vomer, by the spinous suture;—by their sockets, to the teeth by gomphosis;—by the internal edge of the palate-plate, to one another, by the longitudinal palate-suture; on the upper and fore-part of which a furrow is left for receiving the cartilage which forms the partition of the nostrils;—between the fore-part of the nostrils and mouth, to each other, by the mystachial suture;—sometimes they are connected to the ossa spongiosa inferiora, by a plain concretion or union of substance.

These bones form the greater part of the nose and of the roof of the mouth, and a considerable share of the orbit. They contain sixteen teeth, give rise to muscles, transmission to nerves, &c. as mentioned in the description of their several parts.

OSSA PALATI are commonly described as two small square bones, at the back-part of the palate or roof of the mouth, though they are of much greater extent, being continued up the back-part of the nostrils to the orbit. Each palate-bone may therefore be divided into four parts, the palate square bone, the pterygoid process, nasal lamella, and orbital process.

The square bone is unequally concave, for enlarging both the mouth and cavity of the nose. The upper part of its internal edge rises in a spine, after the same manner as the palate-plate of the maxillary bone does, to be joined with the vomer.—Its anterior edge is unequally ragged, for its firmer connection with the palate-process of the os maxillare.—The internal edge is thicker than the rest, and of an equal surface, for its conjunction with its fellow of the other side.—Behind, this bone is somewhat in form of a crescent, and thick, for the firm connection of the velum pendulum palati; the internal point being produced backwards, to afford origin to the palato-staphylinus, or azygos-muscle.—This square bone is well distinguished from the pterygoid process by a perpendicular fossa, which, applied to such another in the maxillary bone, forms a passage for the palatine branch of the fifth pair of nerves; and by another small hole behind this, through which a twig of the same nerve passes.

The pterygoid process is somewhat triangular, having a broad base, and ending smaller above. The back-part of this process has three fossæ formed in it; the two lateral receive the ends of the two plates of the sphenoid bone, that are commonly compared to a bat's wing; the middle fossa makes up a part of what is commonly called the *fossa pterygoidea*; the fore-side of this palatine pterygoid process is an irregular concave, where it receives the back-part of the great tuberosity of the maxillary bone.—Frequently several small holes may be observed in this triangular process, particularly one near the middle of its base, which, a little above, communicates with the common and proper holes of this bone already taken notice of.

The nasal lamella of this bone is extremely thin and brittle, and rises upwards from the upper side of the external edge of the square bone, and from the narrow extremity of the pterygoid process; where it is so weak, and at the same time so firmly fixed to the maxillary bone, as to be very liable to be broken in separating the bones.—From the part where the plate rises, it runs up broad on the inside of the tuberosity of the maxillary bone, to form a considerable share of the sides of the maxillary sinus, and to close up the space between the sphenoid and the great bulge of the maxillary bone, where there would otherwise be a large slit opening into the nostrils. From the middle internal side of this thin plate, a cross ridge, placed on such another of the maxillary bone, is extended; on it the back-part of the os spongiosum

*spongiosum inferius* rests.—Along the outside of this plate, the perpendicular fossa made by the palate-nerve is observable.

At the upper part of this nasal plate, the palate-bone divides into two processes, which were already named *orbital*,—between which and the body of the sphenoid bone, that hole is formed, which was mentioned as the last of the holes common to the sphenoid bone.—Sometimes this hole is wholly formed in the *os palati*, by a cross plate going from the one orbital process to the other. A nerve, artery, and vein belonging to the nostrils, pass here.—The anterior of the two orbital processes is the largest, and has its fore-part contiguous to the back-part of the maxillary sinus, and its upper surface appears in the bottom of the orbit, behind the back-part of the *os maxillare* and *planum*.—It has cells behind, resembling those of the ethmoid bone, to which it is contiguous; it is placed on the aperture of the sinus sphenoidalis, so as to leave only a round hole at its upper fore-part.—The other part of the orbital process is extended along the internal side of the upper back-part of the maxillary tuberosity, to the base of the sphenoid bone, between the root of the processus azygos and the pterygoid process.

The palate-bones are joined to the maxillary, by the fore-edge of the palate square-bone, by the transverse palate-suture:—By their thin nasal plates, and part of their orbital processes, to the same bones, by the palato-maxillares sutures:—By their pterygoid processes, and back-part of the nasal plates, to the *ala vesperilionum*, by the sphenoid suture:—By the transverse ridges of the nasal plates, to the *ossa spongiosa inferiora*, by contact; hence frequently there is an intimate union of the substance of these bones in old skulls:—By the orbital processes, to the *ossa plana* and *cellula ethmoidæ*, by the ethmoid suture:—To the body of the sphenoid bone, by the sphenoid suture:—By the internal edge of the square-bones, to each other, by the longitudinal palate-suture; and by their nasal spines, to the vomer, by the spinous suture.

The palate-bones form part of the palate, nostrils, orbits, and fossæ pterygoideæ, and they cover part of the sinus maxillares, sphenoidales, and ethmoidici.

*Ossa TURBINATA*, or *spongiosa inferiora*, resemble the superior *ossa spongiosa* in shape and substance, but have their anterior and upper edges contiguous to the transverse ridges of the nasal processes of the maxillary and palate-bones.—From their upper straight edge, two small processes stand out: the posterior, which is the broadest, descends to cover some of the antrum Highmorianum; the anterior rises up to join the *os unguis*, and to make part of the lacrymal duct.

Below the spongy bones already mentioned, there are sometimes two others, one in each nostril, which seem to be a production of the sides of the maxillary sinus turned downwards. When this third sort of spongy bones is found, the middle one of the three in each nostril is the largest, and the lowest is the smallest.—Besides all these, there are often several other small bones knocking out into the nostrils, that, from their shape,

might also deserve the name of *turbinata*, but are uncertain in their bulk, situation, and number.

They are joined to the *ossa maxillaria*, *palati*, and *unguis*, especially in old subjects.

Their use is, to straiten the nostrils, to afford a large surface for extending the organ of smelling, to cover part of the *antra maxillaria*, and to assist in forming the under part of the lacrymal ducts, the orifices of which into the nose are concealed by these bones.

VOMER, or bone resembling a ploughshare, is the thirteenth of the upper jaw, without a fellow, forming the lower and back-parts of the partition of the nose.

The figure of this bone is an irregular rhomboid.—Its sides are flat and smooth.—Its posterior edge appears in an oblique direction at the back-part of the nostrils.—The upper one is firmly united to the base of the sphenoid bone, and to the nasal plate of the ethmoid; and, when it can be got separated, is hollow, for receiving the processus azygos of the sphenoid.—The anterior edge has a long furrow in it, where the middle cartilage of the nose enters.—The lower edge is firmly united to the nasal spines of the maxillary and palate-bones.—These edges of this bone are much thicker than its middle, which is as thin as the finest paper.

Its situation is not always perpendicular, but often inclined and bended to one side, as well as the nasal plate of the ethmoid-bone.

The vomer is convex at its upper part, and then is straight as it is extended downwards and forwards, where it is composed of two plates; the edges of which have a great number of small processes, disposed somewhat like the teeth of a saw, but more irregularly, and several of them are reflected back. Between these plates, a deep fossa is left, which, so far as the top of the curvature, is wide, and has strong sides, for receiving the processus azygos of the sphenoid-bone. Beyond the arch forwards, the fossa is narrower and shallower gradually to the point of the bone, receiving for some way the nasal lamella ethmoidea, which is so closely united to the vomer, by the little processes piercing into its substance, as to prevent any separation. The middle cartilage of the nose fills up what remains of the fossa at its fore-part.

—The posterior edge of the vomer, which appears above the back-part of the palate-bones, is broader above; but as it descends forwards, becomes thinner, though it is still solid and firm.—The lower edge of this bone, which rests on the nasal spine of the palate and maxillary bones, has a little furrow on each side, of a small middle ridge, answering to the spines of the bones of different sides, and the interstice between them. This edge and the upper one meet in the pointed fore-end of this bone.

The body of the vomer has a smooth surface, and solid, but thin substance; and towards its sides, where it is thickest, some cancelli may be observed, when the bone is broken.

It is joined above to the sphenoid and ethmoid bones, and to the middle cartilage of the nose, by schindylesis;—below, to the maxillary and palate-bones, by the spinous suture.

The

The vomer divides the nostrils, enlarges the organ of smelling, by allowing place for expanding the membrane of the nose on its sides, and sustains the palate-plates of the maxillary and palate-bones.

MAXILLA INFERIOR, the lower jaw, consists only of one moveable bone, and sixteen teeth incased into it.

This bone, which is somewhat of the figure of the Greek letter *v*, is situated at the lower part of the face, so as its convex middle part is forwards, and its legs are stretched back. It is commonly divided into the chin, sides, and processes.—The chin is the middle fore-part, the extent of which to each side is marked on the external surface by the holes observable there, and internally, by the beginning of an oblique ridge.—Beyond these, the sides appear, and are continued till the bone, by bending upwards, begins to form the processes.

On the fore-part of the chin, a transverse ridge appears in the middle, on each side of which the musculi quadrati, or depressores labii inferioris, and the levatores labii inferioris, depress the bone: And below these prints, a small rising may be observed, where the depressores commence.—On the back-part of the chin, sometimes three, always two, small protuberances appear in the middle. To the uppermost, when it is seen, the frænum of the tongue is connected. From the middle one, the musculi genioglossi rise; and from the lowest, the geniophyoidei have their origin.

At the lower and fore-part of the external surface of each side of the lower jaw, a small eminence may be observed, where the depressor labiorum communis rises. Near the upper edge of the side a ridge runs length-ways, to which the under part of the musculus buccinator is connected.—Internally, towards the upper edge of each side, another ridge appears, from which the mylohyoidei have their origin, and to which the internal membrane of the gums adheres.

In the upper edge of both chin and sides are a great many deep pits or sockets, for receiving the roots of the teeth. The number and magnitude of these sockets are various, because of the different number, as well of the teeth themselves, as of their roots, in different people. These sockets in this lower jaw, as well as in the upper one, are less deep as old age comes on; when freed from the teeth by any means, they are some time after filled up with an osseous net-work, which at last becomes entirely solid, and as smooth as any other part of the bone; so that in a great many old jaws one cannot observe a vestige of the sockets: But then the jaw becomes less, and much narrower.—Hence we may know why the chin and nose of edentulous people are much nearer than before the teeth were lost; while their lips either fall in towards the mouth, or stand prominent forwards.—When new teeth are protruded, new sockets are formed.—The lower edge of the chin and sides is smooth and equal, and is commonly called the *base* of the lower jaw.—The ends of the base, where the jaw turns upwards, are called its angles; the external surface of each of which has several inequalities upon it, where the masseter muscle is inserted; as the internal surface also has, where the pterygoideus internus is inserted, and a liga-

ment, extended from the styloid process of the temporal bone, is fixed.

The processes are two on each side.—The anterior sharp thin coronoid ones have the crotaphyte muscles inserted into them.—The posterior processes, or condyles, terminate in an oblong smooth head, supported by a cervix. The heads, whose greatest length is transverse, and whose convexity is turned forwards, are tipped with a cartilage, as the articulated parts of all other moved bones are.—The fore-part of the root and neck of these condyloid processes are a little hollow and rough, where the external pterygoid muscles are inserted.

The holes of the lower jaw are two on each side; one at the root of the processes internally, where a large branch of the third branch of the fifth pair of nerves enters with an artery, and a vein returns. A small sharp process frequently juts out backwards from the edge at the fore-part of this hole, to which a ligament, extended from the temporal bone, is fixed, which saves the nerve and vessels from being too much pressed by the pterygoid muscles.—From the lower side of this hole, either a small superficial canal or a furrow descends, where a branch of the nerve is lodged, in its way to the mylohyoideus muscle and sublingual gland.—The other hole is external, at the confines of the chin, where branches of the nerve and vessels come out.—The canal betwixt these two holes is formed in the middle of the substance of the bone, and is pierced by a great number of small holes by which the nerves and blood-vessels of the cancelli and teeth pass.

The lower jaw generally receives the roots of sixteen teeth into its sockets, by gomphosis; and its condyloid processes, covered with cartilage, are articulated with the temporal bones.

THE TEETH are the hard white bodies placed in the sockets of both jaws. Their number is generally sixteen above, and as many below; though some people have more, others have fewer.

The broad thick part of each tooth which appears without the socket, is the base, or body.—The smaller processes sunk into the maxillæ, are the roots or fangs, which become gradually smaller towards the end farthest from the base, or are nearly conical, by which the surface of their sides divides the pressure made on the bases, to prevent the soft parts, which are at the small points of the sockets, to be hurt by such pressure.

Without the gums the teeth are covered with no membrane, and they are said to have no proper periosteum within the sockets; but that is supplied by the reflected membrane of the gums; which, after a good injection, may be evidently seen in a young subject, with the vessels from it penetrating into the substance of the teeth; and it may be discovered in any tooth recently pulled, by macerating it in water. The adhesion of this membrane to these roots is strengthened by the small furrows observable on them.

Each tooth is composed of its cortex, or enamel, and an internal bony substance. The cortex has no cavity or place for marrow; and is so solid and hard, that saws or files can with difficulty make impression on it. It is thickest

thickest upon the base, and gradually, as the roots turn smaller, becomes thinner.—The fibres of this enamel are all perpendicular to the internal substance, and are freight on the base, but at the sides are arched with a convex part towards the roots; which makes the teeth resist the compression of any hard body between the jaws, with less danger of breaking these fibres, than if they had been situated transversely. The spongy sockets in which the teeth are placed likewise serve better to prevent such an injury, than a more solid base would have done.

The bony part of the teeth has its fibres running straight, according to the length of the teeth. When it is exposed to the air, by the breaking or falling off of the hard cortex, it soon corrupts. And thence carious teeth are often all hollow within, when a very small hole appears only externally.

The teeth have canals formed in their middle, where-in their nerves and blood-vessels are lodged; which they certainly need, being constantly waited by the attrition they are subjected to in manducation, and for their further growth, not only after they first appear, but even in adults; as is evident when a tooth is taken out: For then the opposite one becomes longer, and those on each side of the empty socket turn broader; so that when the jaws are brought together, it is scarce observable where the tooth is wanting.

The vessels are easily traced so long as they are in the large canal, but can scarce be observed in their distribution from that to the substance of the teeth of adults.—This plentiful supply of vessels must expose the teeth to the same disorders that attack other vascular parts.

Every root of each tooth has such a distinct canal, with vessels and nerves in it. These canals in the teeth with more than one root, come nearer each other, as they approach the base of the tooth: and at last are only separated by very thin plates, which being generally incomplete, allow a communication of all the canals; and frequently one common cavity only appears within the base, in which a pulpy substance, composed of nerves and vessels, is lodged.

The entry of the canals for these vessels is a small hole placed a little to a side of the extreme point of each root; sometimes, especially in old people, this hole is entirely closed up, and consequently the nerves and blood-vessels are destroyed.

The teeth are seen for a considerable time in form of mucus contained in a membrane; afterwards a thin cortical plate, and some few osseous layers appear within the membrane, with a large cavity filled with mucus in the middle; and gradually this exterior shell turns thicker, the cavity decreases, the quantity of mucus is lessened, and this induration proceeds till all the body is formed; from which the roots are afterwards produced.

In young subjects, different stamina, or rudiments of teeth, are to be observed. Those next the gums hinder ordinarily the deeper-seated ones from making their way out, while these prevent the former from sending out roots, or from entering deep into the bony sockets of the jaws; by which they come to be less fixed.

Children are seldom born with teeth; but at two

years of age they have twenty; and their number does not increase till they are about seven years old, when the teeth that first made their way through the gums are thrust out by others that have been formed deeper in the jaw, and some more of the teeth begin to discover themselves farther back in the mouth. About fourteen years of age, some more of the first crop are shed, and the number is increased.—This shedding of the teeth is of good use; for if the first had remained, they would have stood at a great distance one from another; because the teeth are too hard in their outer crust, to increase so fast as the jaws do. Whereas both the second layer, and the teeth that come out late, meeting, while they are soft, with a considerable resistance to their growth in length, from those situated upon them, necessarily come out broad, and fit to make that close guard to the mouth, which they now form.

The teeth are joined to the sockets by gomphosis, and the gums contribute to fix them there; as is evident by the teeth falling out when the gums are any way destroyed, or made too spongy; as in the scurvy or salivations: Whence some call this articulation with the *syllarcolosis*.

The uses of the teeth are to masticate our aliment, and to assist us in the pronunciation of several letters.

Though the teeth so far agree in their structure, yet, because of some things wherein they differ, they are generally divided into three classes, *viz. incisores, canini, and molares.*

The incisores, are the four fore-teeth in each jaw, receiving their name from their office of cutting our aliment; for which they are excellently adapted, being each formed into a sharp-cutting edge at their base, by their fore-side turning inwards there, while they are sloped down and hollowed behind; so that they have the form of wedges; and therefore their power of acting must be considerably increased.

The incisores of the upper jaw, especially the two middle ones, are broader and longer generally than those of the under jaw.

Canini, from the resemblance to dogs tusks, are one on each side of the incisores in each jaw.—The two in the upper jaw are called *eye-teeth*, from the communication of nerves which is said to be betwixt them and the eyes.—The two in the lower jaw are named *angular, or wike-teeth*, because they support the angles of the mouth.

The canini are broader, longer, and stronger, than the incisores.—Their bases are formed into a sharp edge, as the incisores are; only that the edge rises into a point in the middle.—Each of them has generally but one long root, though sometimes they have two. The roots are crooked towards the end.—The canini of the upper jaw are larger, longer, and with more crooked roots, than those of the under jaw.

The dentes molares, or grinders, which have got their name because they grind our food, are generally five in each side of each jaw; in all twenty. Their bases are broader, more scabrous, and with a thinner cortical substance, than the other teeth. They have also more

roots,

roots, and as these roots generally divaricate from each other, the partitions of the sockets between them bear a large share of the great pressure they suffer, and hinder it to act on their points.

The numerous roots of the dentes molares prevent their loosening by the lateral pressure they suffer in grinding; and as the sockets in the upper jaw are more spongy, and the teeth are more liable, by their situation, to fall out, the grinders there have more numerous and more separated roots than in the lower jaw.

According to the division made of the skeleton, we should now proceed to the description of the trunk of the body. But must first consider a bone, which cannot well be said to belong to either the head or the trunk; nor is it immediately joined to any other, and therefore is very seldom preserved with skeletons.

The Os HYOIDES, which is situated horizontally between the root of the tongue and the larynx. It is properly enough named *hyoides*, from the resemblance it bears to the Greek letter *v*, and may, for a clearer demonstration of its structure, be distinguished into its body, cornua, and appendices.

The body is the middle broad part, convex before, and hollow behind.—The convex fore-part is divided into two, by a ridge, into the middle of which the mylo-hyoidei, and into the sides the stylo-hyoidei, muscles are inserted.—Above the ridge, the bone is horizontal, but pitted in the middle by the insertion of the two genio-hyoidei muscles, and a little hollowed more laterally by the basioglossi.—Below the ridge, it is convex, but a little flattened in the middle by the sterno-hyoidei, and pitted more externally by the coraco-hyoidei.—The concavity behind faces backwards and downwards to receive the thyroid cartilage, when the larynx and the os hyoides are pulled towards each other by the action of the sterno-hyoidei and hyothyroidei muscles; and to its upper edge, the ligamentous membranes of the epiglottis, tongue, and thyroid cartilage, are fixed.

The cornua of the os hyoides are stretched backwards from each side of its body, where often a small furrow points out the former separation.—These cornua are not always straight, nor of equal length; their two plain surfaces stand obliquely sloping from above, outwards and downwards.—Into the external, the ceratoglossus is inserted above, and the thyro-hyoideus muscle below; and to the one behind, the ligamentous membrane of the tongue and larynx adheres. Each of the cornua becomes gradually smaller, as it is extended from the base; but each has a round tubercle, from which a moveable cartilage stands out, which is connected to the upper process of the cartilago thyroidea.

Where the body of the os hyoides joins on each side with its cornua, a small styloform process, called *appendix*, rises upwards and backwards, into which the musculi stylo-hyoidei alteri, and part of the hyo-glossi muscles are fixed.

The substance of the os hyoides is cellular, but covered with a firm external plate, which is of sufficient strength to bear the actions of so many muscles as are inserted into it.

It is not articulated with any bone of the body, ex-

cept by means of the muscles and ligaments mentioned.

The use of the os hyoides, is to serve as a solid lever for the muscles to act with, in raising or depressing the tongue and larynx, or in enlarging and diminishing the capacity of the fauces.

## OF THE TRUNK.

THE TRUNK consists of the *spine, pelvis, and thorax.*

THE SPINE is the long pile of bones extended from the condyles of the occiput to the end of the rump. It somewhat resembles two unequal pyramids joined in a common base. It is not, however, straight; for its upper part being drawn backwards by strong muscles, it gradually advances forwards, to support the œsophagus, vessels of the head, &c. Then it turns backwards, to make place enough for the heart and lungs. It is next bended forwards, to support the viscera of the abdomen. It afterwards turns backwards, for the enlargement of the pelvis. And, lastly, it is reflected forwards, for sustaining the lowest great gut.

The spine is commonly divided into true and false vertebræ; the former constituting the long upper pyramid, which has its base below, while the false vertebræ make the shorter lower pyramid, whose base is above.

THE TRUE VERTEBRÆ are the twenty-four upper bones of the spine, on which the several motions of the trunk of our bodies are performed; from which use they have justly got their name.

Each of these vertebræ is composed of its body and processes.

The body is the thick spongy fore-part, which is convex before, concave backwards, horizontal and plain in most of them above and below.—Numerous small holes, especially on the fore and back-part of their surface, give passage to their vessels, and allow the ligaments to enter their substance.—The edges of the body of each vertebra are covered, especially at the fore-part, with a ring of bone firmer and more solid than the substance of the body any where else. These rings are of great use in preventing the spongy bodies from being broken in the motions of the trunk.

Between the bodies of each two adjoining vertebræ, a substance between the nature of ligament and cartilage is interposed; which seems to consist of concentric curve fibres, when it is cut horizontally; but when it is divided perpendicularly, the fibres appear oblique and decussating each other.—The outer part of the intervertebral ligaments is the most solid and hard; and they gradually become softer till they are almost in the form of a glairy liquor in the centre; and therefore these substances were not improperly called *mucous ligaments* by the ancients. The external fibrous part of each is capable of being greatly extended, and of being compressed into a very small space, whilst the middle fluid part is incompressible, or nearly so; and the parts of this ligament between the circumference and centre approach in their properties to either, in proportion to their more solid

or

or more fluid texture. The middle point is therefore a fulcrum or pivot, on which the motion of a ball and socket may be made, with such a gradual yielding of the substance of the ligament, in whichever direction our spines are moved, as saves the body from violent shocks, and their dangerous consequences.—This ligamentocartilaginous substance is firmly fixed to the horizontal surfaces of the bodies of the vertebræ, to connect them, in which it is assisted by a strong membranous ligament, which lines all their concave surface, and by still a stronger ligament, that covers all their anterior convex surface.

From each side of the body of each vertebra, a bony bridge is produced backwards, and to a side; from the posterior end of which, one slanting process rises and another descends; the smooth, and what is generally the flattest side of each of these four processes, which are called the *oblique*, is covered with a smooth cartilage; and the two lower ones of each vertebra, are fitted to, and articulated with the two upper or ascending oblique processes of the vertebra below, having their articular ligaments fixed into the rough line round their edges.

From between the oblique processes of each side the vertebra is stretched out laterally into a process that is named *transverse*.

From the back-part of the roots of the two oblique, and of the transverse process of each side, a broad oblique bony plate is extended backwards, where these meet, the seventh process of the vertebræ takes its rise, and stands out backwards: This being generally sharp pointed, and narrow edged, has therefore been called *spinal* process; from which this whole chain of bones has got its name.

Besides the common ligament which lines all the internal surface of the spinal processes, as well as of the bodies, there are particular ligaments that connect the bony bridges and processes of the contiguous vertebræ together.

The substance of the processes is considerably stronger and firmer, and has a thicker external plate than the bodies of the vertebræ have.

The seven processes form a concavity at their fore-part, which, joined to the one at the back-part of the bodies, makes a great hole, and the holes of all the vertebræ form a long large conduit, for containing the spinal marrow.—In the upper and lower edge of each lateral bridge, there is a notch. These are so adapted to each other in the contiguous vertebræ, as to form a round hole in each side between each two vertebræ, through which the nerves that proceed from the spinal marrow and its blood-vessels pass.

The articulations then of these true vertebræ are plainly double; for their bodies are joined by the intervening cartilage above described, and their oblique processes being tipped with cartilages, are so connected by their ligaments, as to allow a small degree of motion to all sides.

The true vertebræ serve to give us an erect posture; to allow sufficient and secure motion to the head, neck, and trunk of the body, and to support and defend the bowels, and other soft parts.

Though the true vertebræ agree in the general structure which we have hitherto described; yet because of several specialities proper to a particular number, they are commonly divided into three classes, viz. *cervical*, *dorsal*, and *lumbar*.

The cervical are the seven uppermost vertebræ; which are distinguished from the rest by these marks.—Their bodies are smaller and more solid than any others, and flattened on the fore-part, to make way for the œsophagus; or rather this flat figure is owing to the pressure of that pipe, and to the action of the longi colli and anterior recti muscles.—They are also flat behind, where small processes rise, to which the internal ligaments are fixed.—The upper surface of the body of each vertebra is made hollow, by a slanting thin process which is raised on each side:—The lower surface is also excavated, but in a different manner; for here the posterior edge is raised a little, and the one before is produced a considerable way.—Hence we see how the cartilages between those bones are firmly connected, and their articulations are secure.

The cartilages between these vertebræ are thick, especially at their fore-part; which is one reason why the vertebræ advance forward as they descend, and have larger motion.

The oblique processes of these bones of the neck more justly deserve that name than those of any other vertebræ. They are situated slanting; the upper ones having their smooth and almost flat surfaces facing obliquely backwards and upwards, while the inferior oblique processes have their surfaces facing obliquely forwards and downwards.

The transverse processes of these vertebræ are framed in a different manner from those of any other bones of the spine: For besides the common transverse process rising from between the oblique processes of each side, there is a second one that comes out from the side of the body of each vertebra; and these two processes, after leaving a circular hole for the passage of the cervical artery and vein, unite, and are considerably hollowed at their upper part, with rising sides, to protect the nerves that pass in the hollow; and at last each side terminates in an obtuse point, for the insertion of muscles.

The spinal processes of these cervical bones stand nearly straight backwards, are shorter than those of any other vertebræ, and are forked or double at their ends; and hence allow a more convenient insertion to muscles.

So far most of the cervical vertebræ agree; but they have some particular differences, which oblige us to consider them separately.

The first, from its use of supporting the head, has the name of *atlas*; and is also called *epistropheæ*, from the motion it performs on the second.

The atlas, contrary to all the other vertebræ of the spine, has no body; but, instead of it, there is a bony arch.—In the convex fore-part of which, a small rising appears, where the musculi longi colli are inserted; and, on each side of this protuberance, a small cavity may be observed, where the recti interni minores take their rise.—The upper and lower parts of the arch are rough and unequal, where the ligaments that connect

connect this vertebra to the os occipitis, and to the second vertebra, are fixed.—The back-part of the arch is concave, smooth, and covered with a cartilage, in a recent subject, to receive the tooth-like process of the second vertebra.—In a first vertebra, from which the second has been separated, this hollow makes the passage for the spinal marrow to seem much larger than it really is: On each side of it a small rough sinuosity may be remarked, where the ligaments going to the sides of the tooth-like process of the following vertebra are fastened; and on each side, a small rough protuberance and depression is observable, where the transverse ligament, which secures the tooth-like process in the sinuosity, is fixed, and hinders that process from injuring the medulla spinalis in the flexions of the head.

The atlas has as little spinal process as body; but instead thereof, there is a large bony arch, that the muscles which pass over this vertebra at that place might not be hurt in extending the head.

The superior oblique processes of this atlas are large, oblong, hollow, and more horizontal than in any other vertebra.—They rise more in their external than internal brim; by which their articulations with the condyloid of the os occipitis are firmer.—Under the external edge of each of these oblique processes, is the fossa, or deep open channel, in which the vertebral arteries make the circular turn, as they are about to enter the great foramen of the occipital bone, and where the tenth pair of nerves goes out.—The inferior oblique processes extending from within outwards and downwards, are large, concave, and circular. So that this vertebra, contrary to the other six, receives the bones with which it is articulated both above and below.

The transverse processes here are not much hollowed or forked, but are longer and larger than those of any other vertebra of the neck, for the origin and insertion of several muscles.

The hole for the spinal marrow is larger in this than in any other vertebra, not only on account of the marrow being largest here, but also to prevent its being hurt by the motions of this vertebra on the second one.—This large hole, and the long transverse processes, make this the broadest vertebra of the neck.

The condyles of the os occipitis move forwards and backwards in the superior oblique processes of this vertebra; but from the figure of the bones forming these joints, it appears, that very little motion can here be allowed to either side; and there must be still less circular motion.

The second vertebra colli is called *dentata*, from the tooth-like process on the upper part of its body.

The body of this vertebra is somewhat pyramidal, being large, and produced downwards, especially at its fore-side, to enter into a hollow of the vertebra below; while the upper part has a square process with a small point standing out from it. This it is that is imagined to resemble a tooth, and has given name to the vertebra.—The side of this process, on which the hollow of the anterior arch of the first vertebra plays, is convex, smooth, and covered with a cartilage; and it is of the same form behind, for the ligament, which is extended

transversely from one rough protuberance of the first vertebra to the other, and is cartilaginous in the middle, to move on it.

The superior oblique processes of this vertebra dentata are large, circular, very nearly in an horizontal position, and slightly convex, to be adapted to the inferior oblique processes of the first vertebra.

The transverse processes of the vertebra dentata are short, very little hollowed at their upper part, and not forked at their ends; and the canals through which the cervical arteries pass, are reflected outwards about the middle substance of each process; so that the course of these vessels may be directed towards the transverse processes of the first vertebra.

The spinal process of this vertebra dentata is thick, strong, and short, to give sufficient origin to the muscoli recti majores, and obliqui inferiores, and to prevent the confusion of these and other muscles in pulling the head back.

The third vertebra of the neck is by some called *axis*; but this name is applied to it with much less reason than to the second.—This third, and the three below, have nothing particular in their structure; but all their parts come under the general description formerly given, each of them being larger as they descend.

The seventh vertebra of the neck is near to the form of those of the back, having the upper and lower surfaces of its body less hollow than the others.—The oblique processes are more perpendicular;—neither spinal nor transverse processes are forked.—This seventh and the sixth vertebra of the neck have the hole in each of their transverse processes, more frequently divided by a small cross bridge, that goes between the cervical vein and artery, than any of the other vertebrae.

The twelve dorsal may be distinguished from the other vertebrae of the spine by the following marks.

Their bodies are of a middle size, betwixt those of the neck and loins;—they are more convex before than either of the other two sorts; and are flattened laterally by the pressure of the ribs, which are inserted into small cavities formed in their sides. This flattening on their sides, which makes the figure of these vertebrae almost an half oval, is of good use; as it affords a firm articulation to the ribs, allows the trachea arteria to divide at a small angle, and the other large vessels to run secure from the action of the vital organs.—These bodies are more concave behind than any of the other two classes.—Their upper and lower surfaces are horizontal.

The cartilages interposed between the bodies of these vertebrae are thinner than in any other of the true vertebrae; and contribute to the concavity of the spine in the thorax, by being thinnest at their fore-part.

The oblique processes are placed almost perpendicular; the upper ones slanting but a little forwards, and the lower ones slanting as much backwards.—They have not as much convexity or concavity as is worth remarking.—Between the oblique processes of opposite sides, several sharp processes stand out from the upper and lower parts of the plates which join to form the spinal process; into these sharp processes strong ligaments are fixed, for connecting the vertebrae.

The



The transverse processes of the dorsal vertebræ are long, thicker at their ends than in the middle, and turned obliquely backwards.

The spinal processes are long, small, pointed, and sloping downwards and backwards; from their upper and back-part a ridge rises, which is received by a small channel in the fore-part of the spinal process immediately above, which is here connected to it by a ligament.

The conduit of the spinal marrow is here more circular, but, corresponding to the size of that cord, is smaller than in any of the other vertebræ, and a larger share of the holes in the bony bridges, for the transmission of the nerves, is formed in the vertebra above, than in the one below.

The connection of the dorsal vertebræ to the ribs, the thinness of their cartilages, the erect situation of the oblique processes, the length, sloping, and connection of the spinal processes, all contribute to restrain these vertebræ from much motion, which might disturb the actions of the heart and lungs; and, in consequence of the little motion allowed here, the intervertebral cartilages sooner shrivel, by becoming more solid: And therefore, the first remarkable curvature of the spine observed, as people advance to old age, is in the least stretched vertebræ of the back; or old people first become round-shouldered.

The bodies of the four uppermost dorsal vertebræ deviate from the rule of the vertebræ, becoming larger as they descend; for the first of the four is the largest, and the other three below gradually become smaller, to allow the trachea and large vessels to divide at smaller angles.

The two uppermost vertebræ of the back, instead of being very prominent forwards, are flattened by the action of the musculi longi colli and recti majores.

The proportional size of the two little depressions in the body of each vertebra, for receiving the heads of the ribs, seems to vary in the following manner; the depression on the upper edge of each vertebra decreases as far down as the fourth, and after that increases.

The transverse processes are longer in each lower vertebra to the seventh or eighth, with their smooth surfaces, for the tubercles of the ribs, facing gradually more downwards; but afterwards, as they descend, they become shorter, and the smooth surfaces are directed more upwards.

The spinous processes of the vertebræ of the back become gradually longer and more slanting from the first, as far down as the eighth or ninth vertebra; from which they manifestly turn shorter and more erect.

The first vertebra, besides an oblong hollow in its lower edge, that assists in forming the cavity wherein the second rib is received, has the whole cavity for the head of the first rib formed in it.

The second has the name of *axillary*, without any thing particular in its structure.

The eleventh often has the whole cavity for the eleventh rib in its body, and wants the smooth surface on each transverse process.

The twelfth always receives the whole head of the last rib, and has no smooth surface on its transverse processes, which are very short.—The smooth surfaces of its inferior oblique processes face outwards as the lumbar do.

—And we may say in general, that the upper vertebræ of the back lose gradually their resemblance to those of the neck, and the lower ones come nearer to the figure of the lumbar.

The lowest order of the true vertebræ is the lumbar, which are five bones, that may be distinguished from any others by these marks: 1. Their bodies, though of a circular form at their fore-part, are somewhat oblong from one side to the other; which may be occasioned by the pressure of the large vessels, the aorta and cava, and of the viscera. The epiphyses on their edges are larger, and therefore the upper and lower surfaces of their bodies are more concave than is the vertebræ of the back. 2. The cartilages between these vertebræ are much the thickest of any, and render the spine convex within the abdomen, by their greatest thickness being at their fore-part. 3. The oblique processes are strong and deep; those in opposite sides being almost placed in parallel planes; the superior, which are concave, facing inwards, and the convex inferior ones facing outwards: and therefore each of these vertebræ receives the one above it, and is received by the one below; which is not so evident in the other two classes already described. 4. Their transverse processes are small, long, and almost erect, for allowing large motion to each bone, and sufficient insertion to muscles, and for supporting and defending the internal parts. 5. Betwixt the roots of the superior oblique and transverse processes, a small protuberance may be observed, where some of the muscles that raise the trunk of the body are inserted. 6. Their spinal processes are strong, straight, and horizontal, with broad flat sides, and a narrow edge above and below; this last being depressed on each side by muscles. And at the root of these edges, we see rough surfaces for fixing the ligaments. 7. The canal for the numerous cords, called *cauda equina*, into which the spinal marrow divides, is rather larger in these bones than what contains that marrow in the vertebræ of the back. 8. The holes for the passage of the nerves are more equally formed out of both the contiguous vertebræ than in the other classes; the upper one furnishes however the larger share of each hole.

The thick cartilages between these lumbar vertebræ, their deep oblique processes, and their erect spinal processes, are all fit for allowing large motion; though it is not so great as what is performed in the neck; which appears from comparing the arches which the head describes when moving on the neck, or the loins only.

The lumbar vertebræ, as they descend, have their oblique processes at a greater distance from each other, and facing more backwards and forwards.

Both transverse and spinal processes of the middlemost vertebræ of the loins are longest and thickest; in the vertebræ above and below they are less: so that these processes of the first and fifth are the least, to prevent their striking on the ribs or ossa ilium, or their bruising the muscles in the motions of the spine.

The epiphyses round the edges of the bodies of the lumbar vertebræ are most raised in the two lowest, which consequently make them appear hollower in the middle than the others are.

The body of the fifth vertebra is rather thinner than that of the fourth.—The spinal process of this fifth is smaller, and the oblique processes face more backwards and forwards than in any other lumbar vertebra.

The FALSE VERTEBRÆ compose the under pyramid of the spine. They are distinguished from the bones already described justly enough by this epithet of *false*; because, though each bone into which they can be divided in young people, resembles the true vertebræ in figure, yet none of them contribute to the motion of the trunk of the body; they being intimately united to each other in adults, except at their lower part, where they are moveable; whence they are commonly divided into two bones, *os sacrum* and *coccygis*.

OS SACRUM, is so called from being offered in sacrifice by the ancients, is of an irregular triangular shape, broad above, narrow below, convex behind, for the advantageous origin of the muscles that move the spine and thigh backwards; and concave behind, for enlarging the cavity of the pelvis.—Four transverse lines of a colour different from the rest of the bone, which are seen on its fore-part, are the marks of division of the five different bones of which it consists in young persons.

The fore-part of the *os sacrum* is smooth and flat, to allow a larger space for the contained bowels, without any danger of hurting them.—The back-part of it is almost straight, without so large a cavity as the vertebræ have.—The bridges between the bodies and processes of this bone, are much thicker, and in proportion shorter, than in the former class of bones.—The strength of these cross-bridges is very remarkable in the three upper bones, and is well-proportioned to the incumbent weight of the trunk of the body, which these bridges sustain in a transverse, consequently an unfavourable, situation, when the body is erect.

There are only two oblique processes of the *os sacrum*; one standing out on each side from the upper part of the first bone.—Their plain erect surfaces face backwards, and are articulated with the inferior oblique processes of the last vertebra of the loins, to which each of these processes is connected by a strong ligament, which rises from a scabrous cavity round their roots, where mucilaginous glands are also lodged.—Instead of the other oblique processes of this bone, four rough tubercles are to be seen on each side of its surface behind, from which the *musculus sacer* has its origin.

The transverse processes here are all grown together into one large strong oblong process on each side; which, so far as it answers to the first three bones, is very thick, and divided into two irregular cavities, by a long perpendicular ridge.—The foremost of the two cavities has commonly a thin cartilaginous skin covering it in the recent subject, and is adapted to the unequal protuberance of the *os ilium*, and a strong ligament connects the circumference of these surfaces of the two bones.—The cavity behind is divided by a transverse ridge into two, where strong ligamentous strings that go from this bone to the *os ilium*, with a cellular substance containing mucus, are lodged.

The transverse processes of the two last bones of the

*os sacrum* are much smaller than the former.—At their back-part, near their edge, a knob and oblong flat surface give rise to two strong ligaments which are extended to the *os ilchium*; and are therefore called *sacrosciatic*.

The spinal processes of the three uppermost bones of the *os sacrum* appear short, sharp, and almost erect, while the two lower ones are open behind; and sometimes a little knob is to be seen on the fourth, though generally it is bifurcated, without the two legs meeting into a spine; in which condition also the first is often to be seen. The *musculus latissimus*, and *longissimus dorsi*, *sacro-lumbalis*, and *gluteus maximus*, have part of their origins from these spinal processes.

The canal between the bodies and processes of this bone, for the *cauda equina*, is triangular; and becomes smaller as it descends, as the *cauda* also does.—Below the third bone, this passage is no more a complete bony canal, but is open behind; and is only there defended by a strong ligamentous membrane stretched over it, which, with the muscles that cover it, and are very prominent on each side, is a sufficient defence for the bundle of nerves within.

At the root of each oblique process of this bone, the notch is conspicuous, by which, and such another in the last vertebra of the loins, a passage is left for the twenty-fourth spinal nerve; and, in viewing the *os sacrum*; either before or behind, four large holes appear in each side, in much the same height, as where the marks of the union of its several bones remain. Some of the largest nerves of the body pass through the anterior holes; and superficial grooves running outwards from them in different directions, shew the course of these nerves.—From the intervals of these grooves, the *pyriformis* muscle chiefly rises.—The holes in the back-part of the bone are covered by membranes which allow small nerves to pass through them.—The two uppermost of these holes, especially on the fore-side, are the largest; and as the bone descends, the holes turn smaller. Sometimes a notch is only formed at the lower part in each side of this bone; and in other subjects there is a hole common to it and the *os coccygis*, through which the twenty-ninth pair of spinal nerves passes; and frequently a bony bridge is formed on the back-part of each side by a process sent up from the back-part of the *os coccygis*, and joined to the little knobs which the last bone of the *os sacrum* has instead of a spinal process. Under this bridge or jugum, the twenty-ninth pair of spinal nerves runs in its course to the common holes just now described.

The substance of the *os sacrum* is very spongy, without any considerable solid external plates; and is lighter proportionally to its bulk than any other bone in the body; but is secured from injuries by the thick muscles that cover it behind, and by the strong ligamentous membranes that closely adhere to it.

This bone is articulated above to the last vertebra of the loins, in the manner that the lumbar vertebræ are joined; and therefore the same motions may be performed here.—The articulation of the lower part of the *os sacrum* to the *os coccygis* seems well enough adapted for allowing

allowing considerable motion to this last bone, was it not much confined by ligaments. Laterally, the os sacrum is joined to the ossa ilium by an immoveable synchondrosis.

The uses of the os sacrum are, to serve as the common base and support of the trunk of the body, to guard the nerves proceeding from the end of the spinal marrow, to defend the back-part of the pelvis, and to afford sufficient origin to the muscles which move the trunk and thigh.

Os Coccygis, or *rump-bone*, is that triangular chain of bones depending from the os sacrum; each bone becoming smaller as they descend, till the last ends almost in a point. The os coccygis is convex behind, and concave before; from which crooked pyramidal figure, which was thought to resemble a cuckow's beak, it has got its name.

This bone consists of four pieces in people of middle age:—In children, very near the whole of it is cartilage: In old subjects, all the bones are united, and become frequently one continued bone with the os sacrum.

The highest of the four bones is the largest, with shoulders extended farther to each side than the end of the os sacrum;—the upper surface of this bone is a little hollow.—From the back of that bulbous part called its *shoulders*, a process often rises up on each side, to join with the bifurcated spines of the fourth and fifth bones of the os sacrum, to form the bony bridge mentioned in the description of the os sacrum.—Immediately below the shoulders of the os coccygis, a notch may be remarked in each side, where the thirtieth pair of the spinal nerves passes.—The lower end of this bone is formed into a small head, which very often is hollow in the middle.

The three lower bones gradually become smaller, and are spongy; but are strengthened by a strong ligament which covers and connects them.—Their ends, by which they are articulated, are formed in the same manner as those of the first bone are.

The lower end of the fourth bone terminates in a rough point, to which a cartilage is appended.

To the sides of these bones of the os coccygis, the coccygei muscles, and part of the levatores ani, and of the glutæi maximi, are fixed.

The os coccygis serves to sustain the intestinum rectum; and, in order to perform this office more effectually, it is made to turn with a curve forwards; by which also the bone itself, as well as the muscles and teguments, is preserved from any injury, when we sit with our body reclined back.

The second part of the trunk of the skeleton, the PELVIS, is the cylindrical cavity at the lower part of the abdomen, formed by the os sacrum, os coccygis, and ossa innominata; which last therefore fall now in course to be examined.

The OSSA INNOMINATA are two large broad bones, which form the fore-part and sides of the pelvis, and the lower part of the sides of the abdomen.—In children each of these bones is evidently divided into three; which are afterwards so intimately united, that scarce

the least mark of their former separation remains: notwithstanding, they are described as consisting each of three bones, to wit, the os ilium, ischium, and pubis.

OS ILIUM, or *haunch-bone*, is situated highest of the three, and reaches as far down as one third of the great cavity into which the head of the thigh-bone is received.

The external side of this bone is unequally convex, and is called its *dorsum*;—the internal concave surface is by some (but improperly) named *costa*.—The semicircular edge at the highest part of this bone, which is tipped with a cartilage in the recent subject, is named the *spine*, into which the external or descending oblique muscle of the abdomen is inserted; and from it the internal ascending oblique and the transverse muscles of the belly, with the glutæus maximus, quadratus lumborum, and latissimus dorsi, have their origin.—The ends of the spine are more prominent than the surface of the bone below them; therefore are reckoned processes.—From the anterior spinal process, the sartorius and fascialis muscles have their rise, and the outer end of the doubled tendon of the external oblique muscle of the abdomen, commonly called *Fallopian's* or *Poupart's* ligament, is fixed to it.—The inside of the posterior spinal process, and of part of the spine forward from that, is made flat and rough where the sacro-lumbalis and longissimus dorsi rise; and to its outside ligaments, extended to the os sacrum and transverse processes of the fifth and fourth vertebræ of the loins, are fixed.—Below the anterior spinal process another protuberance stands out, which, by its situation, may be distinguished from the former, by adding the epithet of *inferior*, where the musculus rectus tibiæ has its origin.—Betwixt these two anterior processes the bone is hollowed where the beginning of the sartorius muscle is lodged.—Below the posterior spinal processes, a second protuberance of the edge of this bone is in like manner observable, which is closely applied to the os sacrum.—Under this last process a considerable large niche is observable in the os ilium; between the sides of which and the strong ligament that is stretched over from the os sacrum to the sharp-pointed process of the os ischium of the recent subject, a large hole is formed, through which the musculus pyriformis, the great sciatic nerve, and the posterior crural vessels, pass, and are protected from compression.

The external broad side, or dorsum of the os ilium, is a little hollow towards the fore-part; farther back it is as much raised; then is considerably concave; and, lastly, it is convex. These inequalities are occasioned by the actions of the muscles that are situated on this surface.—From behind the uppermost of the two anterior spinal processes, in such bones as are strongly marked by the muscles, a semicircular ridge is extended to the hollow passage of the sciatic nerve. Between the spine and this ridge, the glutæus medius takes its rise. Immediately from above, the lowest of the anterior spinal processes, a second ridge is stretched to the niche. Between this and the former ridge, the glutæus minimus has its origin.—On the outside of the posterior spinal processes, the dorsum of the os ilium is flat and rough, where part of the musculus glutæus maximus and pyriformis rises.—The lowest part of this bone is the thickest, and is formed into a large

large cavity with high brims, to assist in composing the great acetabulum.

The internal surface of the os ilium is concave in its broadest fore part, where the internal iliac muscle has its origin, and some share of the intestinum ilium and colon is lodged.—From this large hollow, a small sinuosity is continued obliquely forwards, at the inside of the anterior inferior spinal process, where part of the psoas and iliacus muscles, with the crural vessels and nerves, pass.—The large concavity is bounded below by a sharp ridge, which runs from behind forwards, and, being continued with such another ridge of the os pubis, forms a line of partition between the abdomen and pelvis.—Into this ridge the broad tendon of the psoas parvus is inserted.

All the internal surface of the os ilium, behind this ridge, is very unequal: For the upper part is flat, but spongy, where the sacro-lumbalis and longissimus dorsi rise.—Lower down, there is a transverse ridge from which ligaments go out to the os sacrum.—Immediately below this ridge, the rough unequal cavities and prominences are placed, which are exactly adapted to those described on the side of the os sacrum.—In the same manner, the upper part of this rough surface is porous, for the firmer adhesion of the ligamentous cellular substance; while the lower part is more solid, and covered with a thin cartilaginous skin, for its immoveable articulation with the os sacrum.

Os ISCHIUM, or *hip-bone*, is of a middle bulk between the two other parts of the os innominatum, is situated lowest of the three, and is of a very irregular figure.—Its extent might be marked by an horizontal line drawn near through the middle of the acetabulum; for the upper bulbous part of this bone forms some less than the lower half of that great cavity, and the small leg of it rises to much the same height on the other side of the great hole common to this bone and the os pubis.

From the upper thick part of the os ischium, a sharp process, called by some *spinous*, stands out backwards, from which chiefly the musculus coccygeus and superior gemellus, and part of the levator ani, rise; and the anterior or internal sacrosciatic ligament is fixed to it.—Immediately below this process, a sinuosity is formed for the tendon of the musculus obturator internus.—In a recent subject, this part of the bone, which serves as a pulley on which the obturator muscle plays, is covered with a ligamentous cartilage, that, by two or three small ridges, points out the interstices of the fibres in the tendon of this muscle.—The outer surface of the bone at the root of this spinous process is made hollow by the pyriformis, or iliacus externus muscle.

Below the sinuosity for the obturator muscle, is the great knob or tuberosity, covered with cartilage or tendon.—The upper part of the tuberosity gives rise to the inferior gemellus muscle.—To a ridge at the inside of this, the external or posterior sacrosciatic ligament is so fixed, that between it, the internal ligament, and the sinuosity of the os ischium, a passage is left for the internal obturator muscle.—The upper thick smooth part of the tuber, called by some its *dorsum*, has two oblique impressions on it. The inner one gives origin to

the long head of the biceps flexor tibiae and semimembranosus muscles, and the semimembranosus rises from the exterior one, which reaches higher and nearer the acetabulum than the other.—The lower, thinner, more scabrous part of the knob which bends forwards, is also marked with two flat surfaces, whereof the internal is what we lean upon in sitting, and the external gives rise to the largest head of the triceps adductor femoris.—Between the external margin of the tuberosity, and the great hole of the os innominatum, there is frequently an obtuse ridge extended down from the acetabulum, which gives origin to the quadratus femoris.—As the tuber advances forwards, it becomes smaller, and is rough, for the origin of the musculus transversalis and erector penis.—The small leg of it, which mounts upwards to join the os pubis, is rough and prominent at its edge, where the two lower heads of the triceps or quadriceps adductor femoris take their rise.

The upper and back part of the os ischium is broad and thick; but its lower and fore-part is narrower and thinner.

The os ilium and pubis of the same side are the only bones which are contiguous to the os ischium.

The Os PUBIS, or *share-bone*, is the least of the three parts of the os innominatum, and is placed at the upper fore-part of it.—The thick largest part of this bone is employed in forming the acetabulum; from which, becoming much smaller, it is stretched inwards to its fellow of the other side, where again it grows larger, and sends a small branch downwards to join the end of the small leg of the os ischium.—The upper fore-part of each os pubis is tuberosus and rough where the musculus rectus and pyramidalis are inserted.—From this a ridge is extended along the upper edge of the bone, in a continued line with such another of the os ilium, which divides the abdomen and pelvis. The ligament of Fallopius is fixed to the internal end of this ridge, and the smooth hollow below it is made by the psoas and iliacus internus muscles passing with the anterior crural vessels and nerves behind the ligament.—Some way below the former ridge, another is extended from the tuberosus part of the os pubis downwards, and outwards towards the acetabulum; between these two ridges the bone is hollow and smooth, for lodging the head of the pectineus muscle.—Immediately below, where the lower ridge is to take the turn downwards, a winding notch is made, which is comprehended in the great foramen of a skeleton, but is formed into a hole by a subtended ligament in the recent subject, for the passage of the posterior crural nerve, an artery, and a vein.—The internal end of the os pubis is rough and unequal, for the firmer adhesion of the thick ligamentous cartilage that connects it to its fellow of the other side:—The process which goes down from that to the os ischium is broad and rough before, where the gracilis and upper heads of the triceps, or rather quadriceps adductor femoris, have their origin.

Between the os ischium and pubis a very large irregular hole is left, which, from its resemblance to a door or shield, has been called *thyroides*. This hole is all, except the notch for the posterior crural nerve, filled up, in a recent subject, with a strong ligamentous membrane, that

that adheres very firmly to its circumference. From this membrane chiefly the two obturator muscles, external and internal, take their rise.—The great design of this hole, besides rendering the bone lighter, is to allow a strong enough origin to the obturator muscles, and sufficient space for lodging their bellies, that there may be no danger of disturbing the functions of the contained viscera of the pelvis by the actions of the internal, nor of the external being bruised by the thigh-bone, especially by its lesser trochanter, in the motions of the thigh inwards.—The bowels sometimes make their way through the niche for the vessels, at the upper part of this thyroid hole, which causes a hernia in this place.

In the external surface of the *ossa innominata*, near the outside of the great hole, a large deep cavity is formed by all the three bones conjunctly: For the *os pubis* constitutes about one fifth; the *os ilium* makes something less than two fifths, and the *os ischium* as much more than two fifths. The brims of this cavity are very high, and are still much more enlarged by the ligamentous cartilage, with which they are tipped in a recent subject. From this form of the cavity it has been called *acetabulum*; and, for a distinguishing character, the name of the bone that constitutes the largest share of it is added; therefore *acetabulum ossis ischii* is the name this cavity commonly bears.—Round the base of the supercilia the bone is rough and unequal, where the capsular ligament of the articulation is fixed.—The brims at the upper and back-part of the acetabulum are much larger and higher than any where else; which is very necessary to prevent the head of the femur from slipping out of its cavity at this place, where the whole weight of the body bears upon it, and consequently would otherwise be constantly in danger of thrusting it out.—As these brims are extended downwards and forwards, they become less; and at their internal lower part a breach is made in them; from the one side of which to the other, a ligament is placed in the recent subject; under which a large hole is left, which contains a fatty cellular substance and vessels.—Besides this difference in the height of the brims, the acetabulum is otherwise unequal: For the lower internal part of it is depressed below the cartilaginous surface of the upper-part, and is not covered with cartilage; into the upper-part of this particular depression, where it is deepest and of a femilunar form, the ligament of the thigh-bone, commonly called the *round one*, is inserted; while in its more superficial lower part the large mucilaginous gland of this joint is lodged. The largest share of this separate depression is formed in the *os ischium*.

The *ossa innominata* are joined at their back-part to each side of the *os sacrum* by a sort of suture, with a very thin intervening cartilage, which serves as so much glue to cement these bones together; and strong ligaments go from the circumference of this unequal surface to connect them more firmly. The *ossa innominata* are connected together at their fore-part by the ligamentous cartilage interposed between the two *ossa pubis*.—These bones can therefore have no motion in a natural state, except what is common to the trunk of the body, or to the *os sacrum*.

Each *os innominatum* affords a socket (the *acetabulum*) for the thigh-bones to move in, and the trunk of the body rolls here so much on the heads of the thigh-bones, as to allow the most conspicuous motions of the trunk, which are commonly thought to be performed by the bones of the spine.

The pelvis then has a large open above where it is continued with the abdomen, is strongly fenced by bones on the sides, back, and fore-part, and appears with a wide opening below, in the skeleton; but, in the recent subject, a considerable part of the opening is filled by the sacrosciatic ligaments, pyriform, internal obturator; levatores ani, gemini, and coccygæi muscles, which support and protect the contained parts better than bones could have done; so that space is only left at the lowest part of it, for the large excretories, the vesica urinaria, intestinum rectum, and in females, the uterus, to discharge themselves.

The *THORAX*, or *chest*, reaches from below the neck to the belly; and, by means of the bones that guard it, is formed into a large cavity: The figure of which is somewhat conoidal.

The bones which form the thorax are the twelve dorsal vertebrae behind, the ribs on the sides, and the sternum before.

The vertebrae have already been described as part of the spine.

The Ribs, or *costæ*, (as if they were *custodes*, or guards, to those principal organs of the animal machine, the heart and lungs), are the long crooked bones placed at the side of the chest, in an oblique direction downwards in respect of the back-bone.—Their number is generally twelve on each side; though frequently eleven or thirteen have been found.

The ribs are all concave internally; where they are also made smooth by the action of the contained parts, which, on this account, are in no danger of being hurt by them; and they are convex externally, that they might resist that part of the pressure of the atmosphere, which is not balanced by the air within the lungs, during inspiration.—The ends of the ribs next the vertebrae are rounder than they are after these bones have advanced forwards, when they become flatter and broader, and have an upper and lower edge, each of which is made rough by the action of the intercostal muscles, inserted into them.—The upper edge of the ribs is more obtuse and rounder than the lower, which is depressed on its internal side by a long fossa, for lodging the intercostal vessels and nerves; on each side of which there is a ridge, to which the intercostal muscles are fixed. The fossa is not observable however at either end of the ribs: for, at the posterior or root, the vessels have not yet reached the ribs; and, at the fore-end, they are split away into branches, to serve the parts between the ribs.

At the posterior end of each rib, a little head is formed, which is divided by a middle ridge into two plain or hollow surfaces; the lowest of which is the broadest and deepest in most of them. The two plains are joined to the bodies of two different vertebrae, and the ridge forces itself into the intervening cartilage.—

A little way from this head, we find, on the external surface, a small cavity, where mucilaginous glands are lodged; and round the head, the bone appears spongy, where the capsular ligament of the articulation is fixed.—Immediately beyond this a flattened tubercle rises, with a small cavity at, and roughness about its root, for the articulation of the rib with the transverse process of the lowest of the two vertebræ, with the bodies of which the head of the rib is joined.—Advancing further on this external surface, we observe in most of the ribs another smaller tubercle, into which ligaments which connect the ribs to each other, and to the transverse processes of the vertebræ, and portions of the longissimus dorsi, are inserted.—Beyond this the ribs are made flat by the sacro-lumbalis muscle, which is inserted into the part of this flat surface farthest from the spine, where each rib makes a considerable curve, called by some its *angle*.—Then the rib begins to turn broad, and continues so to its anterior end, which is hollow and spongy, for the reception of, and firm coalition with the cartilage that runs thence to be inserted into the sternum, or to be joined with some other cartilage.

To the fore-end of each rib a long broad and strong cartilage is fixed, and reaches thence to the sternum, or is joined to the cartilage of the next rib. This course, however, is not in a straight line with the rib; for generally the cartilages make a considerable curve, the concave part of which is upwards; therefore, at their insertion into the sternum, they make an obtuse angle above, and an acute one below.—These cartilages, as all others, are firmer and harder internally, than they are on their external surface.

The ribs then are articulated at each end, of which the one behind is doubly joined to the vertebræ; for the head is received into the cavities of two bodies of the vertebræ, and the larger tubercle is received into the depression in the transverse process of the lower vertebra.

Hitherto we have laid down the general structure and connection of the ribs, and shall next mark their differences.

In viewing the ribs from above downwards, their figure is still straighter; the uppermost being the most crooked of any.—Their obliquity, in respect of the spine, increases as they descend; so that though their distances from each other is very little different at their back-part, yet at their fore-ends the distances between the lower ones must increase.

The length of the ribs increases from the first and uppermost rib, as far down as the seventh; and from that to the twelfth, as gradually diminishes.—The superior of the two plain, or rather hollow surfaces, by which the ribs are articulated to the bodies of the vertebræ, gradually increases from the first to the fourth rib, and is diminished after that in each lower rib.—The distance of their angles from the heads always increases as they descend to the ninth, because of the greater breadth of the sacro-lumbalis muscle.

The ribs are commonly divided into *true* and *false*.

The *true* costæ are the seven upper ones of each side, whose cartilages are all gradually longer as the ribs descend, and are joined to the breast-bone; so that being pressed

constantly between two bones, they are flattened at both ends, and are thicker, harder, and more liable to ossify, than the other cartilages that are not subject to so much pressure. These ribs include the heart and lungs; and therefore are the proper or true custodes of life.

The five inferior ribs of each side are the *false* or *bastard*, whose cartilages do not reach to the sternum; and therefore, wanting the resistance at their fore-part, they are there pointed; and, on this account, having less pressure, their substance is softer.—The cartilages of these false ribs are shorter as the ribs descend.—To all these five ribs the circular edge of the diaphragm is connected; and its fibres, instead of being stretched immediately transversely, and so running perpendicular to the ribs, are pressed so as to be often, especially in expiration, parallel to the plane in which the ribs lie.

The first rib of each side is so situated, that the flat sides are above and below, while one edge is placed inwards, and the other outwards, or nearly so; therefore sufficient space is left above it for the subclavian vessels and muscle; and the broad concave surface is opposed to the lungs: But then, in consequence of this situation, the channel for the intercostal vessels is not to be found, and the edges are differently formed from all the other, except the second; the lower one being rounded, and the other sharp.—The head of this rib is not divided into two plain surfaces by a middle ridge, because it is only articulated with the first vertebra of the thorax.—Its cartilage is ossified in adults, and is united to the sternum at right angles.—Frequently this first rib has a ridge rising near the middle of its posterior edge, where one of the heads of the scalenus muscle rises.—Farther forward it is flattened, or sometimes depressed by the clavicle.

The fifth, sixth, and seventh, or rather the sixth, seventh, eighth, and sometimes the fifth, sixth, seventh, eighth, ninth ribs, have their cartilages at least contiguous; and frequently they are joined to each other by cross cartilages; and most commonly the cartilages of the eighth, ninth, tenth, are connected to the former, and to each other, by firm ligaments.

The eleventh, and sometimes the tenth rib, has no tubercle for its articulation with the transverse process of the vertebra, to which it is only loosely fixed by ligaments.—The fossa in its lower edge is not so deep as in the upper ribs, because the vessels run more towards the interstice between the ribs.—Its fore-end is smaller than its body, and its short small cartilage is but loosely connected to the cartilage of the rib above.

The twelfth rib is the shortest and straightest.—Its head is only articulated with the last vertebra of the thorax; therefore is not divided into two surfaces.—This rib is not joined to the transverse process of the vertebra, and therefore has no tubercle, being often pulled necessarily inwards by the diaphragm, which an articulation with the transverse process would not have allowed.—The fossa is not found at its under edge, because the vessels run below it.—The fore-part of this rib is smaller than its middle, and has only a very small-pointed cartilage fixed to it.—To its whole internal side the diaphragm is connected.

The

The **STERNUM**, or *breast-bone*, is the broad flat bone or pile of bones, at the fore-part of the thorax.—In adults of a middle age, it is composed of three bones, which easily separate after the cartilages connecting them are destroyed. Frequently the two lower bones are found intimately united; and very often in old people, the sternum is a continued bony substance from one end to the other; though we still observe two, sometimes three, transverse lines on its surface; which are marks of the former divisions.

When we consider the sternum as one bone, we find it broadest and thickest above, and becoming smaller as it descends. The internal surface of this bone is somewhat hollowed for enlarging the thorax; but the convexity on the external surface is not so conspicuous, because the sides are pressed outwards by the true ribs; the round heads of whose cartilages are received into seven smooth pits, formed in each side of the sternum, and are kept firm there by strong ligaments, which, on the external surface, have a particular radiated texture.—The pits at the upper part of the sternum are at the greatest distance one from another, and, as they descend, are nearer; so that the two lowest are contiguous.

The first of the three bones that compose the sternum, all agree, is somewhat of the figure of a heart, as it is commonly painted; only it does not terminate in a sharp point.—This is the uppermost thickest part of the sternum.

The upper middle part of this first bone, where it is thickest, is hollowed, to make place for the trachea arteria; though this cavity is principally formed by the bone being raised on each side of it, partly by the clavicles thrusting it inwards, and partly by the sterno-mastoidi muscles pulling it upwards.—On the outside of each tubercle, there is an oblong cavity, that, in viewing it transversely from before backwards, appears a little convex: Into these glenæ the ends of the clavicles are received.—In the side of the under end of this first bone, the half of the pit for the second rib on each side is formed.—The upper part of the surface behind is covered with a strong ligament, which secures the clavicles.

The second or middle division of this bone, is much longer, narrower, and thinner than the first; but, excepting that it is a little narrower above than below, it is nearly equal all over in its dimensions of breadth or thickness.—In the sides of it are complete pits for the third, fourth, fifth, and sixth ribs, and as half of the pits for the second and seventh.

The third bone is much less than the other two, and has only one half of the pit for the seventh rib formed in it; wherefore it might be reckoned only an appendix of the sternum.—In young subjects it is always cartilaginous, and is better known by the name of *cartilago xiphoïdes*, or *ensiformis*, than any other; though the ancients often called the whole *sternum ensiforme*.—This third bone is seldom of the same figure, magnitude, or situation in any two subjects; for sometimes it is a plain triangular bone, with one of the angles below, and perpendicular to the middle of the upper side, by which it is connected to the second bone.—In other people, the

point is turned to one side, or obliquely forwards or backwards.—Frequently it is all nearly of an equal breadth, and in several subjects it is bifurcated; whence some writers give it the name of *furcella*, or *furcula inferior*; or else it is unossified in the middle.—In the greatest number of adults it is ossified, and tipped with a cartilage; in some, one half of it is cartilaginous; and in others, it is all in a cartilaginous state.—Generally several oblique ligaments, fixed at one end to the cartilages of the ribs, and by the other to the outer surface of the xiphoid-bone, connect it firmly to those cartilages.

The uses of the sternum are, to afford origin and insertion to several muscles; to sustain the mediastinum; to defend the vital organs, the heart and lungs, at the fore-part; and, lastly, by serving as a moveable fulcrum of the ribs, to assist considerably in respiration.

## OF THE SUPERIOR EXTREMITIES.

EACH superior extremity is divided into the *shoulder, arm, fore-arm, and hand*.

The **SHOULDER** consists of the *clavicle* and *scapula*. **CLAVICULA**, or *collar-bone*, is the long crooked bone, in figure like like an Italic *f*, placed almost horizontally between the upper lateral part of the sternum, and what is commonly called the top of the shoulder, which, as a clavis or beam, it bears off from the trunk of the body.

The clavicle, as well as other long round bones, is larger at its two ends than in the middle. The end next to the sternum is triangular: The angle behind is considerably produced, to form a sharp ridge, to which the transverse ligament extended from one clavicle to the other is fixed.—The side opposite to this is somewhat rounded.—The middle of this protuberant end is as irregularly hollowed, as the cavity in the sternum for receiving it is raised; but, in a recent subject, the irregular concavities of both are supplied by a moveable cartilage, which is not only much more closely connected every where, by ligaments, to the circumference of the articulation, than those of the lower jaw are; but it grows to the two bones at both its internal and external ends; its substance at the internal end being soft, but very strong, and resembling the intervertebral cartilages.

From this internal end the clavicle, for about two fifths of its length, is bended obliquely forwards and downwards. On the upper and fore-part of this curvature a small ridge is seen, with a plain rough surface before it; whence the *musculus sterno-hyoideus* and *sterno-mastoidius* have in part their origin.—Near the lower angle, a small plain surface is often to be remarked, where the first rib and this bone are contiguous, and are connected by a firm ligament.—From this a rough plain surface is extended outwards, where the pectoral muscle has part of its origin.—Behind, the bone is made flat and rough: by the insertion of the larger share of the subclavian muscle.—After the clavicle begins to be bended backwards, it is round, but soon after becomes broad and thin; which shape it retains to its external end.—Along the external concavity, a rough sinuosity runs, from which some part of the deltoid muscle takes its rise.—Opposite to this, on the convex edge, a scabrous ridge

ridge gives insertion to a share of the cucullaris muscle. The upper surface of the clavicle here is flat; but the lower is hollow, for lodging the beginning of the musculus subclavius; and towards its back-part a tubercle rises, to which, and a roughness near it, the strong short thick ligament connecting this bone to the coracoid process of the scapula is fixed.

The external end of this bone is horizontally oblong, smooth, sloping at the posterior side, and tipped in a recent subject with a cartilage, for its articulation with the acromion scapulæ.

The medullary arteries, having their direction obliquely outwards, enter the clavicles by one or more small passages in the middle of their back-part.

The triangular unequal interior end of each clavicle, has the cartilage above described interposed betwixt it and the irregular cavity of the sternum.—The ligaments, which surround this articulation to secure it, are so short and strong, that little motion can be allowed any way; and the strong ligament that is stretched across the upper furcula of the sternum, from the posterior prominent angle of the one clavicle, to the same place of the other clavicle, serves to keep each of these bones more firmly in their place.—By the assistance, however, of the moveable intervening cartilage, the clavicle can, at this joint, be raised or depressed, and moved backwards and forwards so much, as that the external end, which is at a great distance from that axis, enjoys very conspicuous motions.

The uses of the clavicles are, to keep the scapulæ, and consequently all the superior extremities, from falling in and forward upon the thorax.

SCAPULA, or *shoulder-blade*, is the triangular bone situated on the outside of the ribs, with its longest side, called its *base*, towards the spinal processes of the vertebrae, and with the angle at the upper part of this side about three inches, and the lower angle at a greater distance from these processes.—The back-part of the scapula has nothing but the thin ends of the ferratus anticus major, and subscapularis muscles, between it and the ribs: But as this bone advances forwards, its distance from the ribs increases.—The upper, or shortest side, called the *superior costa* of the scapula, is nearly horizontal, and parallel with the second rib.—The lower side, which is named the *inferior costa*, is extended obliquely from the third to the eighth rib.—The inferior angle of the scapula is very acute; and the upper one is near to a right angle.—The body of this bone is concave towards the ribs, and convex behind, where it has the name of *dorsum*.—Three processes are generally reckoned to proceed from the scapula.—The first is the large spine that rises from its convex surface behind, and divides it unequally.—The second process stands out from the fore-part of the upper side; and, from its imaginary resemblance to a crow's beak, is named *coracoides*.—The third process is the whole thick bulbous fore-part of the bone.

After thus naming the several constituent parts of the scapula, the particular description will be more easily understood.

The base, which is tipped with cartilage, is not all

streight: For, above the spine, it runs obliquely forwards to the superior angle; that here it might not be too protuberant backwards, and so bruise the muscles and teguments: Into the oblique space the musculus patientiæ is inserted.—At the root of the spine, on the back-part of the base, a triangular plain surface is formed, by the pressure of the lower fibres of the trapezius.—Below this the edge of the scapula is scabrous and rough, for the insertion of the ferratus major anticus, and rhomboid muscles.

The back-part of the inferior angle is made smooth by the latissimus dorsi passing over it. This muscle also alters the direction of the inferior costa, some way forwards from this angle: and so far it is flattened behind by the origin of the teres major.—As the inferior costa advances forwards, it is of considerable thickness, is slightly hollowed and made smooth behind by the teres minor, while it has a fossa formed into it below by part of the subscapularis; and between the two a ridge, with a small depression, appears, where the longus extensor cubiti has its origin.

The superior costa is very thin; and near its fore-part there is a semilunar notch, from one end of which to the other a ligament is stretched; and sometimes the bone is continued, to form one, or sometimes two holes, for the passage of the scapular blood-vessels and nerves.—Immediately behind this semilunar cavity, the coraco-hyoid muscle has its rise.—From the notch, to the termination of the fossa for the teres minor, the scapula is narrower than any where else, and supports the third process. This part has the name of *corvix*.

The whole dorsum of the scapula is always said to be convex; but, by reason of the raised edges that surround it, it is divided into two cavities by the spine, which is stretched from behind forwards, much nearer to the superior than to the inferior costa.—The cavity above the spine is concave where the supra-spinatus muscle is lodged; while the surface of this bone below the spine, on which the infra-spinatus muscle is placed, is convex, except a fossa that runs at the side of the inferior costa.

The internal or anterior surface of this bone is hollow, except in the part above the spine, which is convex.—The subscapularis muscle is extended over this surface, where it forms several ridges and intermediate depressions, commonly mistaken for prints of the ribs; they point out the interstices of the bundles of fibres of which the subscapularis muscle is composed.

The spine rises small at the base of the scapula, and becomes higher and broader as it advances forwards.—On the sides it is unequally hollowed and crooked, by the actions of the adjacent muscles.—Its ridge is divided into two rough flat surfaces: Into the upper one, the trapezius muscle is inserted; and the lower one has part of the deltoid fixed to it.—The end of the spine, called *acromion*, or top of the shoulder, is broad and flat, and is sometimes only joined to the spine by a cartilage.—The anterior edge of the acromion is flat, smooth, and covered with a cartilage, for its articulation with the external end of the clavicle; and it is hollowed below, to allow a passage to the infra and supra-spinati muscles, and free motion to the os humeri.

The



The coracoid process is crooked, with its point inclining forwards; so that a hollow is left at the lower side of its root, for the passage of the infra-scapularis muscle. —The end of this process is marked with three plain surfaces. Into the internal, the serratus minor anticus is inserted: From the external, one head of the biceps flexor cubiti rises; and from the lower one, the coraco-brachialis has its origin. —At the upper part of the root of this process, immediately before the femilunar cavity, a smooth tubercle appears, where a ligament from the clavicle is fixed. From all the external side of this coracoid apophyse, a broad ligament goes out, which becomes narrower where it is fixed to the acromion.

From the cervix scapulæ the third process is produced. The fore-part of this is formed into a glenoid cavity, which is of the shape of the longitudinal section of an egg, being broad below, and narrow above. —Between the brims of this hollow, and the fore-part of the root of the spine, a large sinuosity is left, for the transmission of the supra and infra-spinati muscles; and, on the upper part of these brims, we may remark a smooth surface, where the second head of the biceps flexor cubiti has its origin. —The root of the supercilia is rough all round, for the firmer adhesion of the capsular ligament of the articulation, and of the cartilage which is placed on these brims, where it is thick, but becomes very thin as it is continued towards the middle of the cavity, which it lines all over.

The medullary vessels enter the scapula near the base of the spine.

The scapula and clavicle are joined by plain surfaces, tipped with cartilage; by which neither bone is allowed any considerable motion, being tightly tied down by the common capsular ligament, and by a very strong one which proceeds from the coracoid process; but divides into two before it is fixed into the clavicle, with such a direction, as either can allow this bone to have a small rotation, in which its posterior edge turns more backwards, while the anterior one rises farther forwards; or it can yield to the fore-part of the scapula moving downwards, while the back-part of it is drawn upwards; in both which cases, the oblong smooth articulated surfaces of the clavicle and scapula are not in the same plane, but stand a little transversely, or across each other, and thereby preserve this joint from luxations, to which it would be subject, if either of the bones was to move on the other perpendicularly up and down, without any rotation. —The scapula is connected to the head, os hyoides, vertebræ, ribs, and arm-bone, by muscles, that have one end fastened to these bones, and the other to the scapula, which can move it upwards, downwards, backwards, or forwards; by the quick succession of these motions, its whole body is carried in a circle.

The use of the scapula is, to serve as a fulcrum to the arm; and, by altering its position on different occasions, to allow always the head of the os humeri a right situated socket to move in; and thereby to assist and to enlarge greatly the motions of the superior extremity, and to afford the muscles which rise from it more advantageous actions, by altering their directions to the bone which they are to move.

The ARM has only one bone; best known by the Latin name of *os humeri*; which is long, round, and nearly straight.

The upper end of this bone is formed into a large, round, smooth head, whose middle point is not in a straight line with the axis of the bone, but stands obliquely backwards from it. —The extent of the head is distinguished by a circular fossa surrounding its base, where the head is united to the bone, and the capsular ligament of the joint is fixed. —Below the fore-part of its base two tubercles stand out: The smallest one, which is situated most to the inside, has the tendon of the subscapularis muscle inserted into it. —The larger more external protuberance is divided, at its upper part, into three smooth plain surfaces; into the anterior of which, the musculus supra-spinatus; into the middle or largest, the infra-spinatus; into the one behind, the teres minor, is inserted. —Between these two tubercles, exactly in the fore part of the bone, a deep long fossa is formed, for lodging the tendinous head of the biceps flexor cubiti. —On each side of this fossa, as it descends in the os humeri, a rough ridge, gently flattened in the middle, runs from the roots of the tubercles. —The tendon of the pectoral muscle is fixed into the anterior of these ridges, and the latissimus dorsi, and teres major, are inserted into the internal one. —A little behind the lower end of this last, another rough ridge may be observed, where the coraco-brachialis is inserted. —From the back-part of the root of the largest tubercle, a ridge also is continued, from which the brevis extensor cubiti rises. —This bone is flattened on the inside, about its middle, by the belly of the biceps flexor cubiti. —In the middle of this plain surface, the entry of the medullary artery is seen slanting obliquely downwards. —At the fore-side of this plane, the bone rises in a sort of ridge, which is rough, and often has a great many small holes in it, where the tendon of the strong deltoid muscle is inserted; on each side of which the bone is smooth and flat, where the brachiceus internus rises. The exterior of these two flat surfaces is the largest; behind it a superficial spiral channel, formed by the muscular nerve and the vessels that accompany it, runs from behind forwards and downwards. —The body of the os humeri is flattened behind by the extensors of the fore-arm. —Near the lower end of this bone, a large sharp ridge is extended on its outside, from which the musculus spinator radii longus, and the longest head of the extensor carpi radialis rise. —Opposite to this, there is another small ridge, to which the aponeurotic tendon, that gives origin to the fibres of the internal and external brachii muscles, is fixed; and from a little depression on the fore-side of it, the pronator radii-teres rises.

The body of the os humeri becomes gradually broader towards the lower end, where it has several processes; at the roots of which there is a cavity before, and another behind. The anterior is divided, by a ridge, into two; the external, which is the least, receives the end of the radius; and the internal receives the coronoid process of the ulna in the flexion of the fore-arm, while the posterior deep triangular cavity lodges the olecranon in the extensions of that member. —The sides of the

the posterior cavity are stretched out into two processes, one on each side: These are called *condyles*; from each of which a strong ligament goes out to the bones of the fore-arm.—The external condyle, which has an oblique direction also forwards in respect of the internal, when the arm is in the most natural posture, is equally broad; and has an obtuse smooth head rising from it forwards.—From the rough part of the condyle, the inferior head of the bicornis, the extensor digitorum communis, extensor carpi ulnaris, anconæus, and some part of the supinator radii brevis, take their rise; and on the smooth head the upper end of the radius plays.—Immediately on the outside of this, there is a sinuosity made by the shorter head of the bicornis muscle, upon which the muscular nerve is placed.—The internal condyle is more pointed and protuberant than the external, to give origin to some part of the flexor carpi radialis, pronator radii teres, palmaris longus, flexor digitorum sublimis, and flexor carpi ulnaris.—Between the two condyles, is the trochlea or pulley, which consists of two lateral protuberances, and a middle cavity, that are smooth, and covered with cartilage.—When the fore-arm is extended, the tendon of the internal brachiiæus muscle is lodged in the fore-part of the cavity of this pulley.—The external protuberance, which is less than the other, has a sharp edge behind; but forwards, this ridge is obtuse, and only separated from the little head, already described, by a small fossa, in which the joined edges of the ulna and radius move.—The internal protuberance of the pulley is largest and highest; and therefore, in the motions of the ulna upon it, that bone would be inclined outwards, was it not supported by the radius on that side.—Between this internal protuberance and condyle, a sinuosity may be remarked, where the ulnar nerve passes.

The round head at the upper end of this bone is articulated with the glenoid cavity of the scapula; which being superficial, and having long ligaments, allows the arm a free and extensive motion.

The motions which the arm enjoys by this articulation, are to every side; and by the succession of these different motions, a circle may be described. Besides which, the bone performs a small rotation round its own axis.

The *FORE-ARM* consists of two long bones, the ulna and radius; whose situation, in respect of each other, is oblique in the least straining or most natural posture; that is, the ulna is not directly behind, nor on the outside of the radius, but in a middle situation between these two, and the radius crosses it.—In the following description, by the term *posterior* is meant that part which is in the same direction with the back of the hand; by *anterior*, that answering to the palm; by *internal*, that on the same side with the thumb; by *external*, the side nearest the little finger.

*ULNA*, so named from its being used as a measure, is the longest of the two bones of the fore-arm, and situated on the outside of the radius.

At the upper end of the ulna are two processes.—The posterior is the largest, and formed like a hook, whose concave surface moves upon the pulley of the os humeri, and is called *olecranon*, or top of the cubit.—The convex back-part of it is rough and scabrous, where the lon-

gus, brevis, and brachiiæus externus, are inserted. The olecranon makes it unnecessary that the tendons of the extensor muscles should pass over the end of the os humeri; which would have been of ill consequence in the great flexions of this joint, or when any considerable external force is applied to this part.—The anterior process is not so large, nor does it reach so high as the one behind; but is sharper at its end, and therefore is named *coronoid*.—Between these two processes, a large semicircular or sigmoid concavity is left; the surface of which, on each side of a middle rising, is slanting, and exactly adapted to the pulley of the bone of the arm.—Across the middle of it, there is a small sinuosity for lodging mucilaginous glands; where, as well as in a small hollow on the internal side of it, the cartilage that lines the rest of its surface is wanting.—Round the brims of this concavity the bone is rough, where the capsular ligament of the joint is implanted.—Immediately below the olecranon, on the back-part of the ulna, a flat, triangular, spongy surface appears, on which we commonly lean.—At the internal side of this, there is a larger hollow surface, where the musculus anconæus is lodged; and the ridge at the inside of this gives rise to the musculus supinator radii brevis.—Between the top of the ridge and the coronoid process, is the semilunated smooth cavity, lined with cartilage, in which, and a ligament extended from the one to the other end of this cavity, the round head of the radius plays.—Immediately below it; a rough hollow gives lodging to mucilaginous glands.—Below the root of the coronoid process, this bone is scabrous and unequal, where the brachiiæus internus is inserted.—On the outside of that, we observe a smooth concavity, where the beginning of the flexor digitorum profundus sprouts out.

The body of the ulna is triangular.—The internal angle is very sharp where the ligament that connects the two bones is fixed;—the sides, which make this angle, are flat and rough, by the action and adhesion of the many muscles which are situated here.—At the distance of one third of the length of the ulna from the top, in its fore-part, the passage of the medullary vessels is to be remarked slanting upwards.—The external side of this bone is smooth, somewhat convex, and the angles at each edge of it are blunted by the pressure of the muscles equally disposed about them.

As this bone descends, it becomes gradually smaller; so that its lower end terminates in a little head, standing on a small neck.—Towards the fore but outer part of which last, an oblique ridge runs, that gives rise to the pronator radii quadratus.—The head is round, smooth, and covered with a cartilage on its internal side, to be received into the semilunar cavity of the radius; while a styloid process rises from its outside, to which is fixed a strong ligament that is extended to the os cuneiforme and pisiforme of the wrist.—Between the back-part of that internal smooth side and this process, a sinuosity is left for the tendon of the extensor carpi ulnaris.—On the fore-part of the root of the process, such another depression may be remarked for the passage of the ulnar artery and nerve.—The end of the bone is smooth, and covered with a cartilage.—Between it and the bones of the

the wrist, a double concave moveable cartilage is interposed; which is a continuation of the cartilage that covers the lower end of the radius, and is connected loosely to the root of the styloid process, and to the rough cavity there, in which mucilaginous glands are lodged.

The ulna is articulated above with the lower end of the os humeri, where these bones have depressions and protuberances corresponding to each other, so as to allow an easy and secure extension of the fore-arm to almost a straight line with the arm, and flexion to a very acute angle; but, by the slanting position of the pulley, the lower part of the fore-arm is turned outwards in the extension, and inwards in the flexion; and a very small kind of rotation is likewise allowed in all positions, especially when the ligaments are most relaxed by the fore-arm being in a middle degree of flexion.—The ulna is also articulated with the radius and carpus, in a manner to be related afterwards.

**RADIUS**, so called from its imagined resemblance to a spoke of a wheel, is the bone placed at the inside of the fore-arm. Its upper end is formed into a circular little head, which is hollowed for an articulation with the tubercle at the side of the pulley of the os humeri; and the half of the round circumference of the head next to the ulna is smooth, and covered with a cartilage, in order to be received into the semilunated cavity of that bone.—Below the head, the radius is much smaller; therefore this part is named its *cervix*, which is made round by the action of the supinator radii brevis.—At the external root of this neck, a tuberosity process rises; in to the outer part of which the biceps flexor cubiti is inserted.—From this a ridge runs downwards and inwards, where the supinator radii brevis is inserted; and a little below, and behind this ridge, there is a rough scabrous surface, where the pronator radii teres is fixed.

The body of the radius is not straight, but convex on its internal and posterior surfaces; where it is also made round by the equal pressure of the circumjacent muscles, particularly of the extensors of the thumb; but the surfaces next to the ulna are flattened and rough, for the origin of the muscles of the hand; and both terminate in a common sharp spine, to which the strong ligament extended betwixt the two bones of the fore-arm is fixed. A little below the beginning of the plain surface, on its fore-part, where the flexor muscle of the last joint of the thumb takes its origin, the passage of the medullary vessels is seen slanting upwards.—The radius becomes broader and flatter towards the lower end, especially on its fore-part, where its pronator quadratus muscle is situated.

The lower end of the radius is larger than the superior; though not in such a disproportion as the upper end of the ulna is larger than its lower end.—Its back-part has a flat strong ridge in the middle, and fossæ on each side.—In a small groove immediately on the outside of the ridge, the tendon of the extensor tertii intermedii pollicis plays.—In a large one beyond this, the tendons of the indicator and of the common extensor muscles of the fingers pass.—Contiguous to the ulna, there is a small depression made by the extensor minimi digiti.

—On the outside of the ridge there is a broad depression, which seems again subdivided, where the two tendons of the bicornis, or extensor carpi radialis, are lodged.—The internal side of this end of the radius is also hollowed by the extensors of the first and second joint of the thumb; immediately above which, a little rough surface shews where the supinator radii longus is inserted.—The ridges at the sides of the grooves, in which the tendons play, have an annular ligament fixed to them, by which the several sheaths for the tendons are formed.—The fore-part of this end of the radius is also depressed, where the flexors of the fingers and flexor carpi radialis pass.—The external side is formed into a semilunated smooth cavity, lined with a cartilage, for receiving the lower end of the ulna.—The lowest part of the radius is formed into an oblong cavity; in the middle of which is a small transverse rising, gently hollowed, for lodging mucilaginous glands; while the rising itself is insinuated into the conjunction of the two bones of the wrist that are received into the cavity.—The internal side of this articulation is fenced by a remarkable process of the radius, from which a ligament goes out to the wrist, as the styloid process of the ulna with its ligament guards it on the outside.

The ends of both the bones of the fore-arm being thicker than the middle, there is a considerable distance between the bodies of these bones; in the larger part of which a strong tendinous, but thin ligament, is extended, to give a large enough surface for the origin of the numerous fibres of the muscles situated here, that are so much sunk between the bones, as to be protected from injuries, which they would otherwise be exposed to.

As the head of the radius receives the tubercle of the os humeri, it is not only bended and extended along, with the ulna, but may be moved round its axis in any position; and that this motion round its axis may be sufficiently large, the ligament of the articulation is extended farther down than ordinary on the neck of this bone, before it is connected to it; and it is very thin at its upper and lower part, but makes a firm ring in the middle.—This bone is also joined to the ulna by a double articulation; for above, a tubercle of the radius plays in a socket of the ulna; whilst below, the radius gives the socket, and the ulna the tubercle: But then the motion performed in these two is very different; for, at the upper end, the radius does no more than turn round its axis; while, at the lower end, it moves in a sort of cycloid upon the round part of the ulna; and as the hand is articulated and firmly connected here with the radius, they must move together.—When the palm is turned uppermost, the radius is said to perform the *supination*; when the back of the hand is above, it is said to be *prone*.

The **HAND** comprehends all from the joint of the wrist to the points of the fingers. Its back-part is convex, for greater firmness and strength; and it is concave before, for containing more surely and conveniently such bodies as we take hold of.

The hand is commonly divided into the *carpus*, *metacarpus*, and *fingers*.

The **CARPUS** is composed of eight small spongy bones, situated at the upper part of the hand, *viz.* the

*os scaphoides, lunare, cuneiforme, pisiforme, trapezium, trapezoides, magnum, unciforme.*

The scaphoides is situated most internally of those that are articulated with the fore-arm.—The lunare is immediately on the outside of the former.—The cuneiforme is placed still more externally, but does not reach so high up as the other two.—The pisiforme stands forwards into the palm from the cuneiforme.—The trapezium is the first of the second row, and is situated betwixt the scaphoides and first joint of the thumb.—The trapezoides is immediately on the outside of the trapezium.—The os magnum is still more external.—The unciforme is farther to the side of the little finger.

Os scaphoides is the largest of the eight except one. It is convex above, concave and oblong below; from which small resemblance of a boat it has got its name.—Its smooth convex surface is divided by a rough middle fossa, which runs obliquely cross it.—The upper largest division is articulated with the radius.—Into the fossa the common ligament of the joint of the wrist is fixed; and the lower division is joined to the trapezium and trapezoides.—The concavity receives more than an half of the round head of the os magnum.—The external side of this hollow is formed into a semilunar plane, to be articulated with the following bone.—The internal, posterior, and anterior edges are rough, for fixing the ligaments that connect it to the surrounding bones.

Os lunare has a smooth convex upper surface, by which it is articulated with the radius.—The internal side, which gives the name to the bone, is in the form of a crescent, and is joined with the scaphoid;—the lower surface is hollow, for receiving part of the head of the os magnum.—On the outside of this cavity is another smooth, but narrow oblong sinusity, for receiving the upper end of the os unciforme:—On the outside of which a small round convexity is found, for its connection with the os cuneiforme. Between the great convexity above, and the first deep inferior cavity, there is a rough fossa, in which the circular ligament of the joint of the wrist is fixed.

Os cuneiforme is broader above, and towards the back of the hand, than it is below and forwards: which gives it the resemblance of a wedge.—The superior slightly convex surface is included in the joint of the wrist, being opposed to the lower end of the ulna.—Below this, the cuneiform bone has a rough fossa, wherein the ligament of the articulation of the wrist is fixed.—On the internal side of this bone, where it is contiguous to the os lunare, it is smooth and slightly concave.—Its lower surface, where it is contiguous to the os unciforme, is oblong, somewhat spiral, and concave.—Near the middle of its anterior surface, a circular plane appears, where the os pisiforme is sustained.

Os pisiforme is almost spherical, except one circular plane, or slightly hollow surface, which is covered with cartilage for its motion on the cuneiform bone; from which its whole rough body is prominent forwards into the palm; having the tendon of the flexor carpi ulnaris, and a ligament from the styloid process of the ulna, fixed to its upper part; the transverse ligament of the wrist is connected to its internal side; ligaments extended to the

unciform bone, and to the os metacarpi of the little finger, are attached to its lower part; the abductor minimi digiti has its origin from its fore-part; and, at the internal side of it, a small depression is formed, for the passage of the ulnar nerve.

Trapezium has four unequal sides and angles in its back-part, from which it has got its name.—Above, its surface is smooth, slightly hollowed, and semicircular, for its conjunction with the os scaphoides.—Its external side is an oblong concave square, for receiving the following bone.—The inferior surface is formed into a pulley; the two protuberant sides of which are external and internal. On this pulley the first bone of the thumb is moved.—At the external side of the external protuberance, a small oblong smooth surface is formed by the os metacarpi indicis.—The fore-part of the trapezium is prominent in the palm, and, near to the external side, has a sinusity in it, where the tendon of the flexor carpi radialis is lodged; on the ligamentous sheath of which the tendon of the flexor tertii internodii pollicis plays: And still more externally the bone is scabrous, where the transverse ligament of the wrist is connected, the abductor and flexor primi internodii pollicis have their origin, and ligaments go out to the first bone of the thumb.

Os trapezoides, so called from the irregular quadrangular figure of its back-part, is the smallest bone of the wrist, except the pisiforme.—The figure of it is an irregular cube.—It has a small hollow surface above, by which it joins the scaphoides; a long convex one internally, where it is contiguous to the trapezium; a small external one, for its conjunction with the os magnum; and an inferior convex surface, the edges of which are however so raised before and behind, that a sort of pulley is formed, where it sustains the os metacarpi indicis.

Os magnum, so called because it is the largest bone of the carpus, is oblong, having four quadrangular sides, with a round upper end, and a triangular plain one below.—The round head is divided by a small rising, opposite to the connection of the os scaphoides and lunare, which together form the cavity for receiving it.—On the inside, a short plain surface joins the os magnum to the trapezoides.—On the outside is a long narrow concave surface, where it is contiguous to the os unciforme.—The lower end, which sustains the metacarpal bone of the middle finger, is triangular, slightly hollowed, and farther advanced on the internal side than on the external, having a considerable oblong depression made on the advanced inside by the metacarpal bone of the fore-finger; and generally there is a small mark of the os metacarpi digiti annularis on its external side.

Os unciforme has got its name from a thin broad process that stands out from it forwards into the palm, and is hollow on its inside, for affording passage to the tendons of the flexors of the fingers. To this process also the transverse ligament is fixed, that binds down and defends these tendons; and the flexor and abductor muscles of the little finger have part of their origin from it.—The upper plain surface is small, convex, and joined with the os lunare:—The internal side is long, and slightly convex, adapted to the contiguous os magnum:—

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The external surface is oblique, and irregularly convex, to be articulated with the cuneiform bone:—The lower end is divided into two concave surfaces; the external is joined with the metacarpal bone of the little finger, and the internal one is fitted to the metacarpal bone of the ring-finger.

The uses of the carpus are, to serve as a base to the hand, to protect its tendons, and to afford it a free large motion.

**METACARPUS** consists of four bones, which sustain the fingers.—Each bone is long and round, with its ends larger than its body.—The upper end, which some call the *base*, is flat and oblong, without any considerable head or cavity; but it is however somewhat hollowed, for the articulation with the carpus: It is made flat and smooth on the sides where these bones are contiguous to each other.—Their bodies are flattened on their back-part by the tendons of the extensors of the fingers.—The anterior surface of these bodies is a little concave, especially in their middle; along which a sharp ridge stands out, which separates the muscoli interossei placed on each side of these bones, which are there made flat and plain by these muscles.

Their lower ends are raised into large oblong smooth heads, whose greatest extent is forwards from the axis of the bone.—At the fore-part of each side of the root of each of these heads, one or two tubercles stand out, for fixing the ligaments that go from one metacarpal bone to another, to preserve them from being drawn asunder:—Round the heads a rough ring may be remarked, for the capsular ligaments of the first joints of the fingers to be fixed to; and both sides of these heads are flat, by pressing on each other.

The concavity on the fore-part of these metacarpal bones, and the placing their basis on the arched carpus, cause them to form a hollow in the palm of the hand, which is often useful to us.—The spaces between them lodge muscles, and their small motion makes them fit supporters for the fingers to play on.

Though the ossa metacarpi so far agree, yet they may be distinguished from each other by the following marks.

The os metacarpi indicis is generally the longest.—Its base, which is articulated with the os trapezoides, is hollow in the middle.—The small ridge on the internal side of this oblong cavity is smaller than the one opposite to it, and is made flat on the side by the trapezium.—The exterior ridge is also smooth, and flat on its outside, for its conjunction with the os magnum; immediately below which, a semicircular smooth flat surface shews the articulation of this to the second metacarpal bone.—The back-part of this base is flattened, where the long head of the extensor carpi radialis is inserted; and its fore-part is prominent; where the tendon of the flexor carpi radialis is fixed.—The external side of the body of this bone is more hollowed by the action of muscles, than the internal.—The tubercle at the internal root of its head is larger than the external.—Its base is so firmly fixed to the bone it is connected with, that it has no motion.

Ossa metacarpi medii digiti is generally the second in length.—Its base is a broad superficial cavity, slanting

outwards; the internal posterior angle of which is so prominent, as to have the appearance of a process.—

The internal side of this base is made plain in the same way as the external side of the former bone, while its external side has two hollow circular surfaces, for joining the third metacarpal bone; and between these surfaces there is a rough fossa, for the adhesion of a ligament, and lodging mucilaginous glands.—The shorter head of the bicornis is inserted into the back-part of this base.—The two sides of this bone are almost equally flattened; only the ridge on the fore-part of the body inclines outwards.—The tubercles at the fore-part of the root of the head are equal.—The motion of this bone is very little more than the first metacarpal one has; and therefore these two firmly resist bodies pressed against them by the thumb, or fingers, or both.

Ossa metacarpi digiti annularis is shorter than the second metacarpal bone.—Its base is semicircular and convex, for its conjunction with the os unciforme.—On its internal side are two smooth convexities, and a middle fossa, adapted to the second metacarpal bone.—The external side has a triangular smooth concave surface to join it with the fourth one. The anterior ridge of its body is situated more to the out than to the in-side.—The tubercles near the head are equal.—The motion of this third metacarpal bone is greater than the motion of the second.

Ossa metacarpi minimi digiti is the smallest and sharpest.—Its base is irregularly convex, and rises slanting outwards.—Its internal side is exactly adapted to the third metacarpal bone.—The external has no smooth surface, because it is not contiguous to any other bone; but it is prominent where the extensor carpi ulnaris is inserted.—As this metacarpal bone is furnished with a proper moving muscle, has the plainest articulation, is most loosely connected and least confined, it not only enjoys a much larger motion than any of the rest, but draws the third bone with it, when the palm of the hand is to be made hollow by its advancement forwards, and by the prominence of the thumb opposite to it.

The **THUMB** and four **FINGERS** are each composed of three long bones.

The thumb is situated obliquely in respect of the fingers, neither opposite directly to them, nor in the same plane with them.—All its bones are much thicker and stronger in proportion to their length, than the bones of the fingers are: Which was extremely necessary, since the thumb counteracts all the fingers.

The first bone of the thumb has its base adapted to the double pulley of the trapezium.—The edge at the fore-part of this base is produced farther than any other part; and round the back-part of the base a rough fossa may be seen, for the connection of the ligaments of this joint.—The body and head of this bone are of the same shape as the ossa metacarpi: only that the body is shorter, and the head flatter, with the tubercles at the fore-part of its root larger.

The articulation of the upper end of this bone is uncommon: For though it has protuberances and depressions adapted to the double pulley of the trapezium; yet it enjoys a circular motion, as the joints do where a

round

round head of one bone plays in the orbicular socket of another; only it is somewhat more confined and less expeditious, but stronger and more secure, than such joints generally are.

The second bone of the thumb has a large base formed into an oblong cavity, whose greatest length is from one side to the other.—Round it several tubercles may be remarked, for the insertion of ligaments.—Its body is convex, or a half-round behind; but flat before, for lodging the tendon of the long flexor of the thumb, which is tied down by ligamentous sheaths that are fixed on each side to the angle at the edge of this flat surface.

The articulation and motion of the upper end of this second bone is as singular as that of the former.—For its cavity being joined to the round head of the first bone, it would seem at first view to enjoy motion in all directions; yet, because of the strength of its lateral ligaments, oblong figure of the joint itself, and mobility of the first joint, it only allows flexion and extension; and these are generally much confined.

The third bone of the thumb is the smallest, with a large base, whose greatest extent is from one side to the other.—This base is formed into two cavities and a middle protuberance, to be adapted to the pulley of the former bone.—Its body is rounded behind; but is flatter than in the former bone, for sustaining the nail.—It is flat and rough before, by the insertion of the flexor tertii internodii.—This bone becomes gradually smaller, till near the lower end, where it is a little enlarged, and has an oval scabrous edge.

The motion of this third bone is confined to flexion and extension.

The orderly disposition of the bones of the fingers into three rows, has made them generally obtain the name of three *phalanges*.—All of them have half-round convex surfaces, covered with an aponeurosis, formed by the tendons of the extensors, lumbricales, and interossei, and placed directly backwards, for their greater strength; and their flat concave part is forwards, for taking hold more surely, and for lodging the tendons of the flexor muscles.—The ligaments for keeping down these tendons are fixed to the angles that are between the convex and concave sides.

The bones of the first phalanx of the fingers answer to the description of the second bone of the thumb: only that the cavity in their base is not so oblong; nor is their motion on the metacarpal bones so much confined; for they can be moved laterally or circularly, but have no rotation, or a very small degree of it, round their axis.

The second bone of the fingers has its base formed into two lateral cavities, and a middle protuberance; while the lower end has two lateral protuberances, and a middle cavity; therefore it is joined at both ends in the same manner, which none of the bones of the thumb are.

The third bone differs nothing from the description of the third bone of the thumb, excepting in the general distinguishing marks; and therefore the second and third phalanx of the fingers enjoy only flexion and extension.

All the difference of the phalanges of the several fingers consists in their magnitude.—The bones of the

middle-finger being the longest and largest.—Those of the fore-finger come next to that in thickness, but not in length, for those of the ring-finger are a little longer: The little finger has the smallest bones. Which disposition is the best contrivance for holding the largest bodies; because the longest fingers are applied to the middle largest periphery of such substances as are of a spherical figure.

The uses of all the parts of our superior extremities are so evident in the common actions of life, that it is needless to enumerate them here; and therefore we shall proceed to the last part of the skeleton.

## OF THE INFERIOR EXTREMITIES.

THE INFERIOR EXTREMITIES depend from the acetabula of the ossa innominata; are commonly divided into three parts, *viz.* the *thigh, leg, and foot*.

The THIGH has only one bone; which is the longest of the body. The situation of it is not perpendicular; for the lower end is inclined considerably inwards: So that the knees are almost contiguous, while there is a considerable distance between the thigh-bones above: Which is of good use to us, since sufficient space is thereby left for the external parts of generation, the two great cloacæ of urine and feces, and for the large thick muscles that move the thigh inwards: And, at the same time, this situation of the thigh-bones renders our progression quicker, surer, straighter, and in less room.

The upper end of the thigh-bone is not continued in a straight line with the body of it, but is set off obliquely inwards and upwards, whereby the distance here between these two bones at their upper part is considerably increased.—This end is formed into a large smooth round head, which is the greater portion of a sphere unequally divided.—Towards its lower internal part, a round rough spongy pit is observable, where the strong ligament, commonly called the *round one*, is fixed, to be extended from thence to the lower internal part of the receiving cavity, where it is considerably broader than near to the head of the thigh-bone.—The small part below the head, called the *cervix*, of the os femoris, has a great many large holes, into which the fibres of the strong ligament, continued from the capsular, enter, and are thereby surely united to it; and round the root of the neck, where it rises from the bone, a rough ridge is found, where the capsular ligament of the articulation itself is connected.—Below the back-part of this root, the large unequal protuberance, called *trochanter major*, stands out; the external convex part of which is distinguished into three different surfaces, whereof the one on the fore-part is scabrous and rough, for the insertion of the glutæus minimus; the superior one is smooth, and has the glutæus medius inserted into it; and the one behind is made flat and smooth by the tendon of the glutæus maximus passing over it.—The upper edge of this process is sharp and pointed at its back-part, where the glutæus medius is fixed; but forwards it is more obtuse, and has two superficial pits formed in it: Into the superior of these, the piriformis is implanted; and the obturator internus and gemini are fixed into the lower

one.

one.—From the backmost prominent part of this great trochanter, a rough ridge runs backwards and downwards, into which the quadratus is inserted.—In the deep hollow, at the internal upper side of this ridge, the obturator externus is implanted.—More internally, a conoid process, called *trochanter minor*, rises, for the insertion of the musculus psoas and iliacus internus, and the pectineus is implanted into a rough hollow below its internal root.—The muscles inserted into these two processes being the principal instruments of the rotatory motion of the thigh, have occasioned the name of *trochanters* to the processes.

The body of the os femoris is convex on the fore-part, and made hollow behind, by the action of the muscles that move it and the leg, and for the convenience of sitting, without bearing too much on these muscles.—The fore-part of the thigh-bone is a little flattened above by the beginning of the crureus muscle, as it is also below by the same muscle and the rectus.—Its external surface is likewise made flat below by the vastus externus; where it is separated from the former by an obtuse ridge.—The vastus internus depresses a little the lower part of the internal surface.—The posterior concave surface has a ridge rising in its middle, commonly called *linea aspera*, into which the triceps is inserted, and the short head of the biceps flexor tibiae rises from it.—At the upper part of it, the medullary vessels enter by a small hole that runs obliquely upwards.—A little above which, there is a rough fossa or two, where the tendon of the glutæus maximus is fixed.—The lower end of the linea aspera divides into two, which descend towards each side.—The two vasti muscles have part of their origin from these ridges; and the long tendon of the triceps is fixed to the internal, by means of part of the fascia aponeurotica of the thigh.—Near the beginning of the internal ridge, there is a discontinuation of the ridge, where the crural artery passes through the aponeurosis.—Between these two rough lines, the bone is made flat by the large blood-vessels and nerves which pass upon it; and near the end of each of these ridges, a small smooth protuberance may often be remarked, where the two heads of the external gastrocnemius muscle take their rise; and from the fore-part of the internal tubercle, a strong ligament is extended to the inside of the tibia.

The lower end of the os femoris is larger than any other part of it, and is formed into a great protuberance on each side, called its *condyles*; between which a considerable cavity is found, especially at the back-part, in which the crural vessels and nerves lie immersed in fat.—The internal condyle is longer than the external.—Each of these processes seems to be divided in its plain smooth surface. The mark of division on the external is a notch, and on the internal a small protuberance. The fore-part of this division, on which the rotula moves, is formed like a pulley, the external side of which is highest.—Behind, there are two oblong large heads, whose greatest extent is backwards, for the motion of the tibia; and from the rough cavity between them, but near to the base of the internal condyle, the strong ligament, commonly called the cross one, has its rise.—A little

above which, a rough protuberance gives insertion to the tendon of the triceps.—The condyles, both on the outer and inner side of the knee, are made flat by the muscles passing along them.—On the back part of the internal, a slight depression is made by the tendons of the gracilis and sartorius; and on the external, such another is formed by the biceps flexor cruris; behind which, a deep fossa is to be observed, where the popliteus muscle has its origin.—From the tubercle immediately before this cavity, a strong round ligament goes out to the upper part of the fibula.—Round this lower end of the thigh-bone, large holes are found, into which the ligaments for the security of the joint are fixed, and blood-vessels pass to the internal substance of the bone.

The thigh-bone being articulated above with the acetabulum of the ossa innominata, which affords its round head a secure and extensive play, can be moved to every side; but is restrained in its motion outwards by the high brims of the cavity; and by the round ligament; for otherwise the head of the bone would have been frequently thrust out at the breach of the brims on the inside, which allows the thigh to move considerably inwards.—The body of this bone enjoys little or no rotatory motion, though the head most commonly moves round its own axis; because the oblique progress of the neck and head from the bone is such, that the rotatory motion of the head can only bring the body of the bone forwards and backwards.—The os femoris is articulated below to the tibia and rotula in the manner afterwards to be described.

The nearness of the small neck to the round head of the thigh-bone, and its upper end being covered with very thick muscles, make greater difficulty in distinguishing between a luxation and fracture here, than in any other part of the body.

The LEG is composed of three bones, *tibia*, *fibula*, and *rotula*.

**TIBIA**, so called from its resemblance to an old musical pipe or flute, is the long, thick, triangular bone, situated at the internal part of the leg, and continued in almost a straight line from the thigh-bone.

The upper end of the tibia is large, bulbous, and spongy, and is divided into two cavities by a rough irregular protuberance, which is hollow at its most prominent part, as well as before and behind. The anterior of the two ligaments that compose the great cross one, is inserted into the middle cavity, and the depression behind receives the posterior ligament.—The two broad cavities at the sides of this protuberance are not equal; for the internal is oblong and deep, to receive the internal condyle of the thigh-bone; while the external is more superficial and rounder, for the external condyle.—In each of these two cavities of a recent subject, a semilunar cartilage is placed, which is thick at its convex edge, and becomes gradually thinner towards the concave or interior edge.—The middle of each of these cartilages is broad, and the ends of them turn narrower and thinner, as they approach the middle protuberance of the tibia.—The thick convex edge of each cartilage is connected to the capsular and other ligaments of the articulation, but so near to their rise from the tibia, that the cartilages

cartilages are not allowed to change place far; while the narrow ends of the cartilages, becoming almost ligaments, are fixed at the insertion of the strong cross ligament into the tibia, and seem to have their substance united with it; therefore a circular hole is left between each cartilage and the ligament, in which the most prominent convex part of each condyle of the thigh-bone moves.—The circumference of these cavities is rough and unequal, for the firm connection of the ligaments of the joint.—Immediately below the edge, at its back-part, two rough flatted protuberances stand out: Into the internal, the tendon of the semimembranosus muscle is inserted; and a part of the cross ligament is fixed to the external.—On the outside of this last tubercle, a smooth slightly-hollowed surface is formed by the action of the popliteus muscle.

Below the fore-part of the upper end of the tibia, a considerable rough protuberance rises, to which the strong tendinous ligament of the rotula is fixed.—On the internal side of this, there is a broad, scabrous, slightly-hollowed surface, to which the internal long ligament of the joint, the aponeurosis of the vastus internus, and the tendons of the semimembranosus, gracilis, and sartorius, are fixed.—Below the external edge of the upper end of the tibia, there is a circular flat surface, covered, in a recent subject, with cartilage, for the articulation of the fibula;—between which and the anterior knob, there is a rough hollow, from which the tibialis anticus, and extensor digitorum longus, take their origin.—From the smooth flat surface, a ridge runs obliquely downwards and inwards, to give rise to part of the solæus, tibialis posticus, and flexor digitorum longus, and insertion to the aponeurosis of the semimembranosus which covers the popliteus, and to some of the external fibres of this last named muscle.—At the inside of this ridge an oblique plain surface is left, where the greatest part of the musculus popliteus is inserted.—The remaining body of the tibia is triangular.—The anterior angle is very sharp, and is commonly called the *spine* or *shin*. This ridge is not straight; but turns first inwards, then outwards, and lastly inwards again.—The plain internal side is smooth and equal, being little subjected to the actions of muscles; but the external side is hollowed above by the tibialis anticus, and below by the extensor digitorum longus, and extensor pollicis longus.—The two angles behind these sides are rounded by the action of the muscles;—the posterior side comprehended between them is not so broad as those already mentioned, but is more oblique and flatted by the action of the tibialis posticus and flexor digitorum longus.—Some way above the middle of the bone, the internal angle terminates, and the bone is made round by the pressure of the musculus solæus.—Near to this, the passage of the medullary vessels is seen slanting obliquely downwards.

The lower end of the tibia is made hollow, but so as a small protuberance rises in the middle.—The internal side of this cavity, which is smooth, and, in a recent subject, is covered with cartilage, is produced into a considerable process, commonly named *malleolus internus*; the point of which is divided by a notch, and from it ligaments are sent out to the foot.—The external side

of this end of the tibia has a rough irregular semilunar cavity formed in it, for receiving the lower end of the fibula.—The posterior side has two lateral grooves, and a small middle protuberance. In the internal depression, the tendons of the musculus tibialis posticus, and flexor digitorum longus, are lodged; and in the external, the tendon of the flexor longus pollicis plays.—From the middle protuberance, ligamentous sheaths go out, for tying down these tendons.

**FIBULA** is the small long bone, placed on the outside of the leg, opposite to the external angle of the tibia; the shape of it is irregularly triangular.

The head of the fibula has a superficial circular cavity formed on its inside, which, in a recent subject, is covered with a cartilage, but so closely connected to the tibia by ligaments, as to allow only a small motion backwards and forwards.—This head is protuberant and rough on its outside, where a strong round ligament, and the musculus biceps, are inserted; and, below the back-part of its internal side, a tubercle may be remarked, that gives rise to the strong tendinous part of the solæus muscle.

The body of this bone is a little crooked inwards and backwards, which figure is owing to the actions of the muscles; but is still further increased by nurses, who often hold children carelessly by the legs.—The sharpest angle of the fibula is forwards, on each side of which the bone is considerably, but unequally, depressed by the bellies of the several muscles that rise from, or act upon it; and, in old people, these muscles make distinct sinuosities for themselves.—The external surface of the fibula is depressed obliquely from above downwards and backwards, by the two peronæi.—Its internal surface is unequally divided into two narrow longitudinal planes, by an oblique ridge extended from the upper part of the anterior angle, to join with the lower end of the internal angle. To this ridge the ligament stretched between the two bones of the leg is connected.—The anterior of the two planes is very narrow above, where the extensor longus digitorum, and extensor longus pollicis, arise from it; but is broader below, where it has the print of the nonus Vesalii.—The posterior plane is broad and hollow, giving origin to the larger share of the tibialis posticus.—The internal angle of this bone has a tendinous membrane fixed to it, from which fibres of the flexor digitorum longus take their rise.—The posterior surface of the fibula is the plainest and smoothest, but is made flat above by the solæus, and is hollowed below by the flexor pollicis longus.—In the middle of this surface the canal for the medullary vessels may be seen slanting downwards.

The lower end of the fibula is extended into a spongy oblong head, on the inside of which is a convex, irregular, and frequently a scabrous surface, that is received by the external hollow of the tibia, and so firmly joined to it by a very thin intermediate cartilage and strong ligaments, that it scarce can move.—Below this, the fibula is stretched out into a coronoid process, that is smooth, covered with cartilage on its internal side, and is there contiguous to the outside of the first bone of the foot, the astragalus, to secure the articulation. This process, named *malleolus externus*, being situated farther back



back than the internal malleolus, and in an oblique direction, obliges us naturally to turn the fore-part of the foot outwards. At the lower internal part of this process, a spongy cavity for mucilaginous glands may be remarked; from its point, ligaments are extended to the astragalus, os calcis, and os naviculare, bones of the foot; and from its inside, short strong ones go out to the astragalus. On the back-part of it, a sinuosity is made by the tendons of the peronæi muscles.—When the ligament extended over these tendons from the one side of the depression to the other is broke, stretched too much, or made weak by a sprain, the tendons frequently start forwards to the outside of the fibula.

The conjunction of the upper end of the fibula with the tibia is, by plain surfaces, tipped with cartilage; and, at its lower end, the cartilage seems to glue the two bones together, not, however, so firmly in young people, but that the motion at the other end of such a long radius is very observable.

The principal use of this bone is to afford origin and insertion to muscles; the direction of which may be a little altered, on proper occasions, by its upper part shuffling backwards and forwards.—It likewise helps to make the articulation of the foot more secure and firm.

ROTULA is the small flat bone situated at the fore-part of the joint of the knee.—Its shape resembles the common figure of the heart with its point downwards.—The anterior convex surface of the rotula is pierced by a great number of holes, into which fibres of the strong ligament that is spread over it enter.—Behind, its surface is smooth, covered with cartilage, and divided by a middle convex ridge into two cavities, of which the external is largest, and both are exactly adapted to the pulley of the os femoris, on which they are placed in the most ordinary unstraining postures of the leg; but when the leg is much bended, the rotula descends far down on the condyles; and when the leg is fully extended, the rotula rises higher, in its upper part, than the pulley of the thigh-bone.—The plain smooth surface is surrounded by a rough prominent edge, to which the capsular ligament adheres:—Below, the point of the bone is scabrous, where the strong tendinous ligament from the tubercle of the tibia is fixed.—The upper horizontal part of this bone is flatted and unequal, where the tendons of the extensors of the leg are inserted.

The substance of the rotula is cellular, with very thin external firm plates: But then these cells are so small, and such a quantity of bone is employed in their formation, that scarce any bone of its bulk is so strong. Besides, it is covered all over with a thick ligament, to connect its substance, and is moveable to one side or other; therefore is sufficiently strong to resist the ordinary actions of the large muscles that are inserted into it, or any common external force applied to it.

The parts which constitute the joint of the knee being now described, let us examine what are its motions, and how performed.—The two principal motions are flexion and extension.—In the former of these, the leg may be brought to a very acute angle with the thigh, by the condyles of the thigh-bones being round and made

smooth far backwards. In performing this, the rotula is pulled down by the tibia.—When the leg is to be extended, the rotula is drawn upwards, consequently the tibia forwards, by the extensor muscles; which, by means of the protuberant joint, and of this thick bone with its ligament, have in effect the chord, with which they act, fixed to the tibia at a considerable angle, therefore act with advantage; but are restrained from pulling the leg farther than to a straight line with the thigh, by the posterior part of the cross ligament, that the body might be supported by a firm perpendicular column: For at this time the thigh and leg are as little moveable in a rotatory way, or to either side, as if they were one continued bone.—But when the joint is a little bended, the rotula is not tightly braced, and the posterior ligament is relaxed; therefore this bone may be moved a little to either side, or with a small rotation in the superficial cavities of the tibia; which is done by the motion of the external cavity backwards and forwards, the internal serving as a sort of axis. Seeing then one part of the cross ligament is situated perpendicularly, and the posterior part is stretched obliquely from the internal condyle of the thigh outwards, that posterior part of the cross ligament prevents the leg's being turned at all inwards; but it could not hinder it from turning outwards almost round, was not that motion confined by the lateral ligaments of this joint, which can yield little.

The FOOT is divided into three parts, viz. *tarfus*, *metatarfus*, and *toes*: In the description of which, the broad of the foot shall be called *superior*; the sole, *inferior*; the side on which the great toe is, *internal*; that where the little toe is, *external*.

The *tarfus* consists of seven spongy bones; to wit, the *astragalus*, or *calcis*, *naviculare*, *cuboides*, *cuneiforme externum*, *cuneiforme medium*, and *cuneiforme internum*.

The *astragalus* is the uppermost of these bones.—The *os calcis* is below the *astragalus*, and is considerably prominent backwards beyond the other bones, to form the heel.—The *os naviculare* is in the middle of the internal side of the *tarfus*.—The *os cuboides* is the most external of the row of four bones at its fore-part.—The *os cuneiforme externum* is placed at the inside of the cuboid.—The *cuneiforme medium* is between the external and internal cuneiform bones, and the internal cuneiform is put at the internal side of the foot.

In the description of these bones, let it be observed, That where-ever a ridge is mentioned, without a particular use assigned, a ligament is understood to be fixed to it: or where a spongy rough cavity, depression, or fossa, is remarked, without naming its use, a ligament is inserted, and mucilaginous glands are lodged.

The upper part of the *astragalus* is formed into a large smooth head, which is slightly hollowed in the middle; and therefore resembles a superficial pulley, by which it is fitted to the lower end of the tibia.—The internal side of this head is flat and smooth, to play on the internal malleolus.—The external side has also such a surface, but larger, for its articulation with the external malleolus.—Round the base of this head there is a rough fossa; and, immediately before the head, as also

below its internal smooth surface, we find a considerable rough cavity.

The lower surface of the astragalus is divided by an irregular, deep, rough fossa; which, at its internal end, is narrow, but gradually widens, as it stretches obliquely outwards and forwards.—The smooth surface, covered with cartilage, behind this fossa, is large, oblong, extended in the same oblique situation with the fossa, and concave, for its conjunction with the os calcis.—The back-part of the edge of this cavity is produced into two sharp-pointed rough processes, between which is a depression, made by the tendon of the flexor pollicis longus.—The lower surface before the fossa is convex, and composed of three distinct smooth planes. The long one behind, and the exterior or shortest, are articulated with the heel-bone; while the internal, which is the most convex of the three, rests and moves upon a cartilaginous ligament, that is continued from the calcaneum to the os scaphoides.

The fore-part of this bone is formed into a convex oblong smooth head, which is received by the os naviculare.—Round the root of this head, especially on the upper surface, a rough fossa may be remarked.

The astragalus is articulated above to the tibia and fibula, which together form one cavity. Though, in this articulation, the bones have prominences and cavities so small, as might allow motions in all directions; yet the flexion and extension are the most considerable, the other motions being confined by the malleoli, and by the strong ligaments which go out from the points of these processes to the astragalus and os calcis. The astragalus is joined below to the os calcis; and before, to the os naviculare, in the manner to be explained when these bones are described.

Calcaneum is the largest bone of the seven.—Behind, it is formed into a large knob, commonly called the *heel*: The surface of which is rough behind, where the tendo Achillis is inserted into it; and above, it is hollow and spongy. Farther forwards, on the upper surface of the calcaneum, there is an irregular, oblong, smooth convexity, adapted to the concavity at the back-part of the astragalus: And beyond this a narrow fossa is seen, which divides it from two small concave smooth surfaces, that are joined to the fore-part of the astragalus.—Behind the posterior of these smooth surfaces, which is the largest, a small sinusity is made by the tendon of the flexor digitorum longus; at the fore-part of which a small rough protuberance appears, that gives rise to the musculus extensor digitorum brevis.

The external side of this bone is flat, with a superficial fossa running horizontally, in which the tendon of the musculus peroneus longus is lodged.—The internal side of the heel-bone is hollowed, for lodging the origin of the massa cornea Jac. Sylvii, and for the safe passage of tendons, nerves, and arteries.—Under the side of the internal smooth concavity, a particular groove is made by the tendon of the flexor pollicis longus; and from the thin protuberance on this internal side, the cartilaginous ligament that supports the astragalus, goes out to the os naviculare; on which ligament, and on the edge of this bone to which it is fixed, the groove is form-

ed for the tendon of the flexor digitorum profundus.

The lower surface of this bone is pressed flat at the back-part, by the weight of our bodies; and immediately before this plane, there are two tubercles, from the internal of which the musculus abductor pollicis, flexor digitorum sublimis, as also part of the aponeurosis plantaris, and of the abductor minimi digiti, have their origin; and the other part of the abductor minimi digiti and aponeurosis plantaris, rises from the external.—Before these protuberances this bone is concave, for lodging the flexor muscles; and at its fore-part we may observe a rough depression, from which, and a tubercle behind it, the ligament goes out that prevents this bone to be separated from the os cuboides.

The fore-part of the os calcis is formed into an oblong, pulley-like, smooth surface, which is circular at its upper external end, but is pointed below. This smooth surface is fitted to the os cuboides.

Though the surfaces by which the astragalus and os calcis are articulated, seem fit enough for motion; yet the very strong ligaments by which these bones are connected, prevent it, and render this principal part of our base, which rests on the ground, to wit, the os calcis, firm.

Os naviculare, is somewhat circular.—It is formed into an oblong concavity behind, for receiving the anterior head of the astragalus.—On the upper surface, there is a rough fossa.—Below, the os naviculare is very unequal and rough; but hollow for the safety of the muscles.—On its inside, a large knob rises out, from which the abductor pollicis takes in part its origin, the tendon of the tibialis posticus is inserted into it, and to it two remarkable ligaments are fixed; the first is the strong one, formerly mentioned, which supports the astragalus; the second is stretched from this bone obliquely across the foot, to the metatarsal bones of the middle toe, and of the toe next to the little one.—On the outside of the os naviculare, there is a semicircular smooth surface, where it is joined to the os cuboides.—The fore-part of this bone is all covered with cartilage, and is divided into three smooth planes, fitted to the three ossa cuneiformia.

The os naviculare and astragalus are joined as a ball and socket, and the naviculare moves in all directions in turning the toes inwards, or in raising or depressing either side of the foot, though the motions are greatly restrained by the ligaments which connect this to the other bones of the tarsus.

Os cuboides is a very irregular cube.—Behind, it is formed into an oblong unequal concavity, adapted to the fore-part of the os calcis.—On its internal side, there is a small semicircular smooth cavity, to join the os naviculare.—Immediately before which, an oblong smooth plane is made by the os cuneiforme externum.—Below this, the bone is hollow and rough.—On the internal side of the lower surface, a round protuberance and fossa are found, where the musculus adductor pollicis has its origin. On the external side of this same surface, there is a round knob, covered with cartilage; immediately before which, a smooth fossa may be observed, in which the tendon of the peroneus primus runs obliquely cross  
the

the foot; and on the knob, the thin flat cartilage proper to this muscle plays; in place of which, sometimes a bone is found:—More externally than the knob, a rough hollow is made, for the strong ligaments stretched betwixt this bone and the os calcis.—Before, the surface of the os cuboides is flat, smooth, and slightly divided into two planes, for sustaining the os metatarsi of the little toe, and of the toe next to it.

The form of the back-part of the os cuboides, and the ligaments connecting the joint there with the os calcis, both concur in allowing little motion in this part.

Os cuneiforme externum, is much of the shape of a wedge, being broad and flat above, with long sides running obliquely downwards, and terminating in a sharp edge.—The upper surface of this bone is an oblong square.—The one behind is nearly a triangle, but not complete at the inferior angle, and is joined to the os naviculare.—The external side is an oblong square, divided as it were by a diagonal: The upper half of it is smooth, for its conjunction with the os cuboides: The other is a scabrous hollow; and in its superior anterior angle, a small smooth impression is made by the os metatarsi of the toe next to the little one.—The internal side of this bone is also quadrangular, with the fore-part of its edge made flat and smooth by the os metatarsi of the toe next to the great one; and the back-part is also flat and smooth, where the os cuneiforme medium is contiguous to it.—The fore-part of this bone is an oblong triangle, for sustaining the os metatarsi of the middle toe.

Os cuneiforme medium, or minimum, is still more exactly the shape of a wedge than the former.—Its upper part is square;—its internal side has a flat smooth surface above and behind, for its conjunction with the following bone; with a small rough fossa below; and a considerable share of it is rough and hollow.—The external side is smooth and a little hollowed, where it is contiguous to the last described bone.—Behind, this bone is triangular, where it is articulated with the os naviculare; and it is also triangular at its fore-part, where it is contiguous to the os metatarsi of the toe next to the great one.

Os cuneiforme maximum, or internum, differs from the two former in its situation, which is more oblique than theirs.—Besides, its broad thick part is placed below, and the small thin point is above and outwards; while its under broad surface is concave, for allowing a safe passage to the flexors of the great toe.—The surface of this os cuneiforme behind, where it is joined to the os naviculare, is hollow, smooth, and of a circular figure below, but pointed above.—The external side consists of two smooth and flat surfaces, whose direction is nearly at right angles with each other. With the posterior, that runs obliquely from below forwards and upwards, the os cuneiforme minimum is joined; and with the anterior, whose direction is longitudinal, the os metatarsi of the toe next to the great one is connected.—The fore-part of this bone is semilunar, but flat and smooth, for sustaining the os metatarsi of the great toe.—The internal side is scabrous, with two remarkable tubercles below, from which the musculus abductor pollicis rises, and the tibialis anticus is inserted into its upper part.

The three cuneiform bones are all so secured by ligaments, that very little motion is allowed in any of them.

These seven bones of the tarsus, when joined, are convex above, and leave a concavity below, for lodging safely the several muscles, tendons, vessels, and nerves that lie in the sole of the foot.—In the recent subject, their upper and lower surfaces are covered with strong ligaments, which adhere firmly to them; and all the bones are so tightly connected, by these and the other ligaments, which are fixed to the rough ridges and fossae formerly mentioned, that, notwithstanding the many surfaces covered with cartilage, some of which are of the form of the very moveable articulations, no more motion is here allowed, than only to prevent too great a shock of the fabric of the body in walking, leaping, &c. by falling on too solid a base.

METATARSUS is composed of five bones, which, in their general characters, agree with the metacarpal bones; but may be distinguished from them by the following marks: 1. They are longer, thicker, and stronger. 2. Their anterior round ends are not so broad, and are less in proportion to their bases. 3. Their bodies are sharper above and flatter on the sides, with their inferior ridge inclined more to the outside. 4. The tubercles at the lower parts of the round head are larger.

The first or internal metatarsal bone is easily distinguished from the rest by its thickness.—The one next to it is the longest, and with its sharp edge almost perpendicular.—The others are shorter and more oblique, as their situation is more external.

Os metatarsi pollicis is by far the thickest and strongest, as having much the greatest weight to sustain. Its base is oblong, irregularly concave, and of a semilunar figure, to be adapted to the os cuneiforme maximum.—The inferior edge of this base is a little prominent and rough, where the tendon of the peronæus primus muscle is inserted.—On its outside, an oblique circular depression is made by the second metatarsal bone.—Its round head has generally on its fore-part a middle ridge, and two oblong cavities, for the ossa scamoidea; and on the external side, a depression is made by the following bone.

Os metatarsi of the second toe, is the longest of the five, with a triangular base supported by the os cuneiforme medium and the external side produced into a process; the end of which is an oblique smooth plane, joined to the os cuneiforme externum.—Near the internal edge of the base, this bone has two small depressions, made by the os cuneiforme maximum, between which is a rough cavity.—Farther forwards, we may observe a smooth protuberance, which is joined to the foregoing bone.—On the outside of the base are two oblong smooth surfaces, for its articulation with the following bone; the superior smooth surface being extended longitudinally, and the inferior perpendicularly; between which there is a rough fossa.

Os metatarsi of the middle toe, is the second in length.—Its base, supported by the os cuneiforme externum, is triangular, but slanting outwards, where it ends in a sharp-pointed little process; and the angle below is not completed.

The

The internal side of this base is adapted to the preceding bone; and the external side has also two smooth surfaces covered with cartilage, but of a different figure; for the upper one is concave, and, being round behind, turns smaller as it advances forwards; and the lower surface is little, smooth, convex, and very near the edge of the base.

Os metatarsi of the fourth toe, is near as long as the former, with a triangular slanting base, joined to the os cuboides, and made round at its external angle, having one hollow smooth surface on the outside, where it is pressed upon by the following bone, and two on the internal side, corresponding to the former bone; behind which is a long narrow surface impressed by the os cuneiforme externum.

Os metatarsi of the little toe, is the shortest, situated with its two flat sides above and below, and with the ridges laterally.—The base of it, part of which rests on the os cuboides, is very large, tuberos, and produced into a long-pointed process externally, where part of the abductor minimi digiti is fixed; and into its upper part the peroneus secundus is inserted.—Its inside has a flat conoidal surface, where it is contiguous to the preceding bone.

When we stand, the fore-ends of these metatarsal bones, and the os calcis, are our only supporters; and therefore it is necessary they should be strong, and should have a confined motion.

The bones of the TOES are much akin to those of the thumb and fingers; particularly the two of the great toe are precisely formed as the two last of the thumb; only their position, in respect of the other toes, is not oblique; and they are proportionally much stronger, because they are subjected to a greater force; for they sustain the force with which our bodies are pushed forwards by the foot behind at every step we make; and on them principally the weight of the body is supported, when we are raised on our tiptoes.

The three bones in each of the other four toes, compared to those of the fingers, differ from them in these particulars.—They are less, and smaller in proportion to their lengths:—Their bases are much larger than their anterior ends: Their bodies are more narrow above and below, and flatter on the sides.—The first phalanx

is proportionally much longer than the bones of the second and third, which are very short.

Of the four, the toe next to the great one has the largest bones in all dimensions, and more externally the toes are less.—The little toe, and frequently that next to it, have the second and third bones intimately united into one; which may be owing to their little motion, and the great pressure they are subjected to.

The toes are of good use to us in walking; for, when the sole is raised, they bring our body, with its centre of gravity, perpendicular to the advanced foot.

The only bones now remaining to complete the description of the skeleton, are the small ones, which are found at the joints of the fingers and toes, and in some other parts, called

OSSA SESAMOIDEA, which are of very different figures and sizes, though they are generally said to resemble the seed of the sesamum.—They seem to be nothing else than the ligaments of the articulations, or the firm tendons of strong muscles, or both, become bony, by the compression which they suffer. Thus the sesamoid bones at the beginning of the gastrocnemii muscles, are evidently composed of the tendinous fibres only.—These, at the first joint of the great toe, are as plainly the same continued substance with the ligaments and the tendons of the adductor, flexor, brevis, and abductor.—That which is sometimes double at the second joint of that toe, is part of the capsular ligament; and if we enumerate the other sesamoid bones that are at any time found, we may observe all of them formed in this manner.—Their number, figure, situation, and magnitude, are so uncertain, that it were in vain to insist on the differences of each; and therefore we shall only in general remark,

1. That where-ever the tendons and ligaments are firmest, the actions of the muscles strongest, and the compression greatest, there such bones are most commonly found.

2. That, *ceteris paribus*, the older the subject is in which they are sought, their number is greater, and their size is larger.

3. The more labour any person is inured to, he has, *ceteris paribus*, the most numerous and largest ossa sesamoidea.

## EXPLANATION OF PLATE XIII.

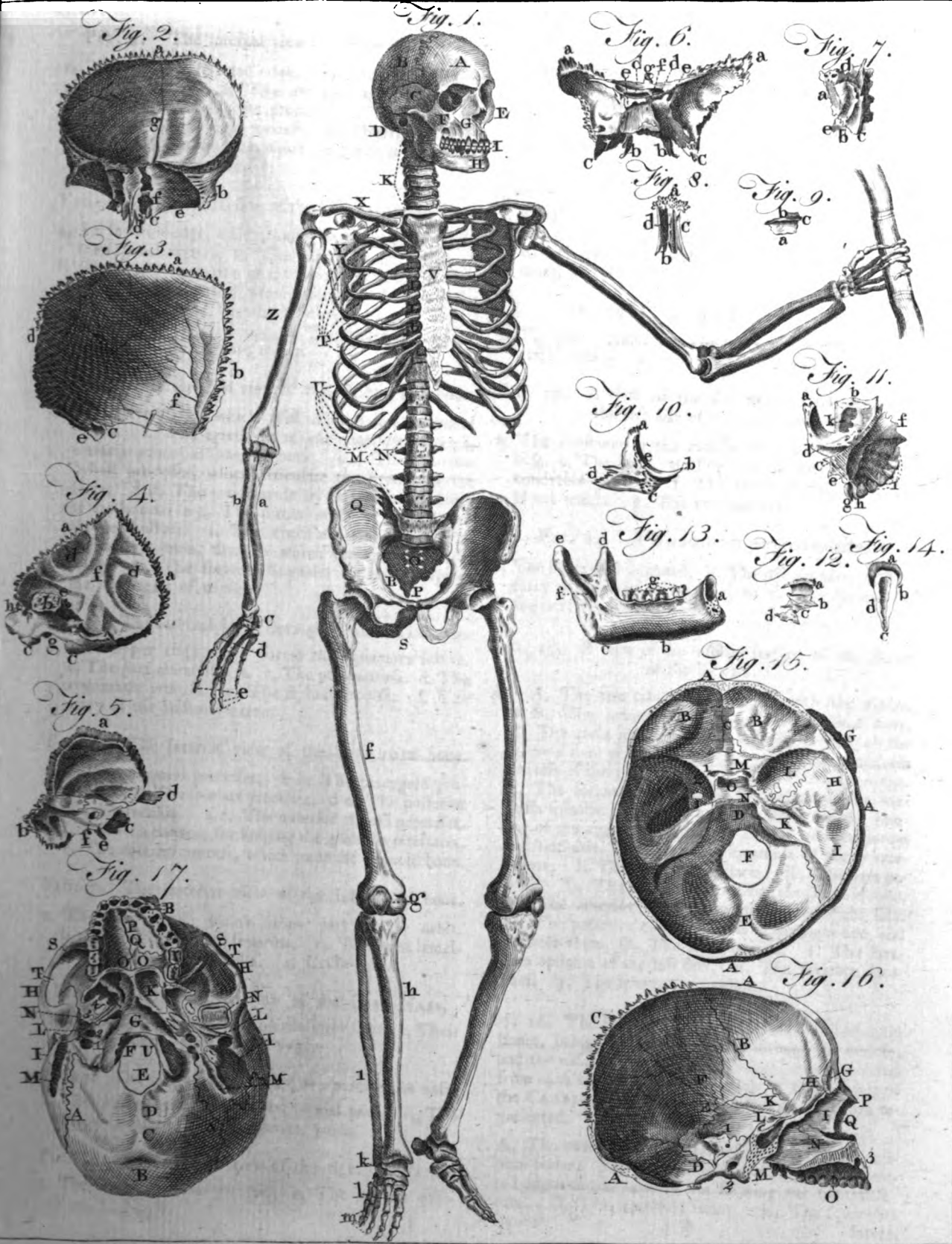
FIGURE I. A MALE SKELETON.

A, Os frontis. B, Os parietale. C, Os temporum. D, Os occipitis. E, Offa nasi. F, Os maxilæ. G, Os maxillare superius. H, Os maxillare inferius. I, The seven vertebræ of the neck, with their intermediate cartilages. L, &c. The twelve dorsal vertebræ, with their intermediate cartilages. M, The five lumbar vertebræ, and, N, Their intermediate cartilages. O, Os

sacrum. P, Os coccygis. Q, Os ilium. R, Os pubis. S, Os ischium. T, The seven true ribs. U, The five false ribs. V, The sternum. X, The clavicle. Y, The scapula. Z, The os humeri, a, Ulna. b, Radius. c, The eight bones of the carpus. d, The five metacarpal bones. e, The phalanges of the fingers. f, The os femoris. g, The patella. h, The tibia. i, The fibula. k, The seven bones of the tarsus. l, The five metatarsal bones. m, The phalanges of the toes.

FIG.

Plate XIII



*W. Bell del.*



FIG. 2. The internal view of the Os FRONTIS.

- a, The superior serrated edge, which assists to form the coronal future. b, The external angular process. c, The internal angular process. d, The nasal process. e, The orbital process. f, The frontal sinus. g, The sagittal future, which (as here) is sometimes continued to the nose.

FIG. 3. The internal side of the left PARIETAL bone.

- a, Its superior edge, which, joined with the other, forms the sagittal future. b, The anterior edge, which assists in the formation of the coronal future. c, The inferior edge for the squamous future. d, The posterior edge for the lambdoid future. e, A depression made by the lateral sinus. f, The prints of the principal artery of the dura mater.

FIG. 4. The internal view of the OCCIPITAL bone.

- a a, The two sides, which assist to form the lambdoid future. b, The extremity of the cuneiform process, where it joins the sphenoid bone. c c, The two condyloid processes, which articulate the head with the spine. d d, The prints made by the posterior lobes of the brain. e e, The prints made by the lobes of the cerebellum. f, The cruciform ridge. g, The foramen magnum, through which the spinal marrow passes. h, The foramen linguale, for the passage of the ninth pair of nerves.

FIG. 5. The internal side of the right TEMPORAL bone.

- a, The upper edge which forms the squamous future. b, The pars mammillaris. c, The pars petrosa. d, The zygomatic process. e, The styloid process. f, The entry of the auditory nerve.

FIG. 6. The internal view of the SPHENOID bone.

- a a, The temporal processes. b b, The pterygoid processes. c c, The spinous processes. d d, The posterior clinoid processes. e e, The anterior clinoid processes. f, The sella turcica, for lodging the glandula pituitaria. g, The anterior process, which joins the ethmoid bone.

FIG. 7. The exterior view of the ETHMOID bone.

- a, The pars plana, which forms part of the orbit. b, The os spongiosum superius. c, The nasal lamella. d, The ethmoid cells. e, Crista galli.

FIG. 8. The posterior view of the OSSA NASI.

- a, Their superior sides. b, Their inferior sides. c, Their exterior sides. d, Their joining.

FIG. 9. The side of the Os UNGUIS next to the nose.

- a, The orbital part. b, The lachrymal part. c, The furrow between these two convex parts.

FIG. 10. The posterior view of the right Os MALÆ.

- a, The superior orbital process. b, The inferior orbital process.

c, The malar process. d, The zygomatic process. e, The internal orbital process.

FIG. 11. A view of the lower part, and side next to the nose, of the right Os MAXILLARE, with the PALATE-BONE, and Os SPONGIOSUM INFERIUS.

- a, The nasal process. b, The tuber, at the top of which is the orbital process, and within it, k, The antrum maxillare. c, The nasal spine. d, The os spongiosum inferius. e, The palate-plate. f, The os palati. g, The two dentes incisores. h, The dens caninus. i, The five dentes molares.

FIG. 12. The right PALATE-BONE.

- a, The palate-plate. b, The pterygoid process. c, The nasal lamella. d, The orbital process.

FIG. 13. A view of the side next to the mouth of the left side of the lower jaw.

- a, The substance in the middle of the chin. b, The base. c, The angle. d, The coronoid process. e, The condyloid process. f, The entry of the nerve and blood-vessels. g, The five molares.

FIG. 14. A TOOTH cut perpendicularly.

- a, The fibres of the enamel. b, The osseous part. c, The entry at the point of the root, to d, The channel for the nerve and blood-vessels.

FIG. 15. A view of the interior surface of the BASE of the SKULL.

- A A A, The two tables of the skull, with the *diploe*. B B, The orbital processes of the *frontal bone*. C, The crista galli, with the cribriform-plate of the *ethmoid bone* on each side of it. D, The cuneiform process of the *os occipitis*. E, The cruciform ridge. F, The foramen magnum for the passage of the *medulla spinalis*. G, The zygoma, made by the joining of the zygomatic processes of the *os temporum* and *occipitis*. H, The *pars squamosa* of the *os temporum*. I, The *pars mammillaris*. K, The *pars petrosa*. L, The temporal process of the *sphenoid bone*. M, The anterior clinoid process of the right side. N, The posterior clinoid process of the right side, and between them, O, The *sella turcica*. 1. The foramen opticum of the left side. 2. The foramen lacernum. 3. The foramen rotundum.

FIG. 16. The frontal, occipital, sphenoid, and ethmoid bones, being cut perpendicularly through the middle, and the nasal, maxillary, and palate bones separated from each other, the interior view of the left side of the CRANIUM, and bones of the UPPER JAW, are represented.

- A A, The two tables and *diploe* of the frontal and occipital bones. B, The coronal future. C, The serrated edges of the parietal, for forming the sagittal future. D, The lambdoid future. E, The squamous future.

future. F, The furrows made by the vessels of the dura mater. G, The frontal sinus. H, The crista galli. I, The nasal lamella of the ethmoid bone. K, The temporal process of the sphenoid bone. L, The sella turcica. M, The sphenoid sinus. N, The vomer. O, The palate-plate of the superior maxillary bone; and from it the processus alveolaris, which contains the teeth. P, The os nasi. Q, The passage into the left nostril. 1. The meatus auditorius internus, for the passage of the auditory nerve. 2. The passage of the ninth pair of nerves. 3. The foramen incisivum.

FIG. 17. The external surface of the base of the CRANIUM and UPPER JAW.

A A, The lambdoid future. B, The superior horizontal ridge of the occipital bone, which is opposite to the criciform ridge, where the superior longitudinal

sinus divides to form the lateral sinuses. C, The perpendicular ridge. D, The inferior horizontal ridge. E, The foramen magnum, for the passage of the medulla spinalis. F F, The two condyles. G, The cuneiform process. H H, The zygomatic process of the temporal bone. I I, The mastoid processes. K, The vomer, which forms the back-part of the septum nasi. L L, The styloid processes. M M, The fossæ at the root of the mastoid processes, for the posterior belly of the digastric muscle. N N, The cavities for receiving the condyles of the lower jaw. O O, The ossa palati. P, The longitudinal palate-future. Q, The transverse palate-future. R, The alveoli, or spongy sockets for the teeth. S, The zygomatic process of the ossa malarum. T T, The zygomatic future. 1. Meatus auditorius externus. 2. Hole for the internal carotid artery. 3. For the artery of the dura mater. 4. Foramen ovale, for the third branch of the fifth pair, to the upper jaw.

EXPLANATION OF PLATE XIV.

FIG. 1. A posterior view of the STERNUM and CLAVICLES, with the ligament connecting the clavicles to each other.

a, The posterior surface of the sternum. b b, The broken ends of the clavicles. c c c c, The tubercles near the extremity of each clavicle. d, The ligament connecting the clavicles.

FIG. 2. A fore view of the LEFT SCAPULA, and of a half of the CLAVICLE, with their ligaments.

a, The spine of the scapula. b, The acromion. c, The inferior angle. d, Inferior costa. e, Cervix. f, Glenoid cavity, covered with cartilage for the arm-bone. g g, The capsular ligament of the joint. h, Coracoid process. i, The broken end of the clavicle. k, Its extremity joined to the acromion. l, A ligament coming out single from the acromion to the coracoid process. m, A ligament coming out single from the acromion, and dividing into two, which are fixed to the coracoid process.

FIG. 3. The joint of the elbow of the LEFT ARM, with the ligaments.

a, The os humeri. b, Its internal condyle. c c, The two prominent parts of its trochlea, appearing through the capsular ligament. d, The ulna. e, The radius. f, The part of the ligament including the head of the radius.

FIG. 4. The BONES of the RIGHT-HAND, with the PALM in view.

a, The radius. b, The ulna. c, The scaphoid bone of the carpus. d, The os lunare. e, The os cuneiforme. f, The os pisiforme. g, Trapezium. h, Trapezoides. i, Capitulatum. k, Unciforme. l, The four metacarpal bones of the fingers. m, The first

phalanx. n, The second phalanx. o, The third phalanx. p, The metacarpal bone of the thumb. q, The first joint. r, The second joint.

FIG. 5. The posterior view of the BONES of the LEFT HAND.

The explication of Fig. 4. serves for this figure; the same letters pointing the same bones, though in a different view.

FIG. 6. The upper extremity of the TIBIA, with the femilunar cartilages of the joint of the knee, and some ligaments.

a, The strong ligament which connects the rotula to the tubercle of the tibia. b b, The parts of the extremity of the tibia, covered with cartilage, which appear within the femilunar cartilages. c c, The femilunar cartilages. d, The two parts of what is called the cross ligament.

FIG. 7. The posterior view of the joint of the RIGHT KNEE.

a, The os femoris cut. b, Its internal condyle. c, Its external condyle. d, The back-part of the tibia. e, The superior extremity of the fibula. f, The edge of the internal femilunar cartilage. g, An oblique ligament. h, A larger perpendicular ligament. i, A ligament connecting the femur and fibula.

FIG. 8. The anterior view of the joint of the RIGHT KNEE.

b, The internal condyle. c, Its external condyle. d, The part of the os femoris, on which the patella moves. e, A perpendicular ligament. f f, The two parts of the crucial ligaments. g g, The edges of the two moveable femilunar cartilages. h, The tibia. i, The



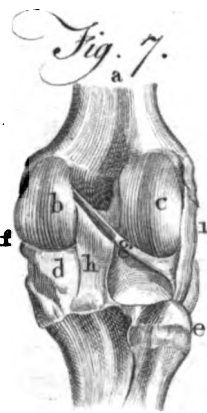
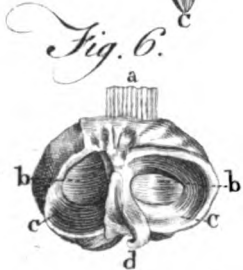
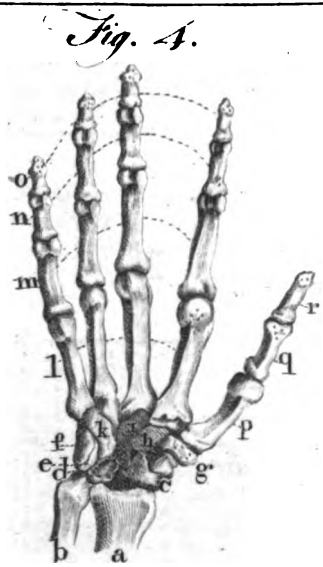
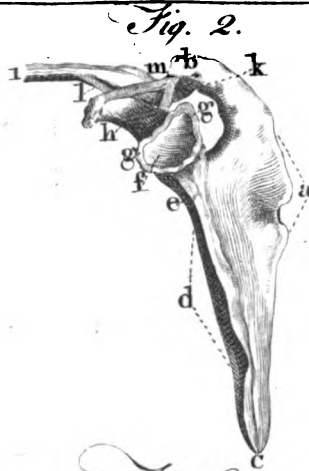


Fig. 10.

Fig. 9.



Fig. 11.

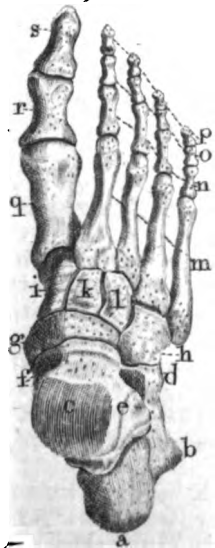


Fig. 12.

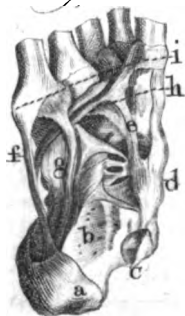


Fig. 13.

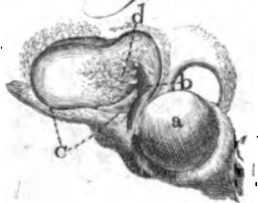


Fig. 14.



Fig. 15.





i, The strong ligament of the patella.—The back-part of it where the fat has been dissected away. l, The external depression. m, The internal one. n, The cut tibia.

FIG. 9. A view of the inferior part of the bones of the RIGHT FOOT.

a, The great knob of the os calcis. b, A prominence on its outside. c, The hollow for the tendons, nerves, and blood-vessels. d, The anterior extremity of the os calcis. e, Part of the astragalus. f, Its head covered with cartilage. g, The internal prominence of the os naviculare. h, The os cuboides. i, The os cuneiforme internum; k, —Medium; l, —Externum. m, The metatarsal bones of the four lesser toes. n, The first—o, The second—p, The third phalanx of the four lesser toes. q, The metatarsal bones of the great toe. r, Its first—s, Its second joint.

FIG. 10. The inferior surface of the two large SESSA-MOID BONES, at the first joint of the great toe.

FIG. 11. The superior view of the bones of the RIGHT FOOT.

a, b, as in Fig. 9. c, The superior head of the astragalus. d, &c. as in Fig. 9.

FIG. 12. The view of the SOLE of the FOOT with its ligaments.

a, The great knob of the os calcis. b, The hollow for the tendons, nerves, and blood-vessels. c, The sheaths of the flexores pollicis and digitorum longi opened. d, The strong cartilaginous ligament supporting the

head of the astragalus. e, h, Two ligaments which unite into one, and are fixed to the metatarsal bone of the great toe. f, A ligament from the knob of the os calcis to the metatarsal bone of the little toe. g, A strong triangular ligament, which supports the bones of the tarsus. i, The ligaments of the joints of the five metatarsal bones.

FIG. 13. a, The head of the thigh-bone of a child. b, The ligamentum rotundum connecting it to the acetabulum. c, The capsular ligament of the joint with its arteries injected. d, The numerous vessels of the mucilaginous gland injected.

FIG. 14. The back view of the cartilages of the LARYNX, with the Os HYOIDES.

a, The posterior part of the base of the os hyoides. b b, Its cornua. c, The appendix of the right side. d, A ligament sent out from the appendix of the left side, to the styloid process of the temporal bone. e, The union of the base with the left cornu. f f, The posterior sides of (g) the thyroid cartilage. h h, Its superior cornua. i i, Its inferior cornua. k, The cricoid cartilage. l l, The arytenoid cartilages. m, The entry into the lungs, named *glottis*. n, The epiglottis. o o, The superior cartilages of the trachea. p, Its ligamentous back-part.

FIG. 15. The superior concave surface of the SESSA-MOID BONES at the first joint of the great toe, with their ligaments.

a, Three sesamoid bones. b, The ligamentous substance in which they are formed.

## P A R T II.

### O F T H E M U S C L E S.

#### SECT. I. *Of the MUSCLES in general.*

THE muscles are bundles of fibres of different figures and sizes, and for the most part consisting of two different portions; one whereof is thick, soft, and more or less red, forming what is called the body, fleshy substance, or belly of the muscle. The other is thin and small, of a close texture, and very white, forming the extremities, termed by anatomists *tendons* or *aponeuroses*. Both portions are covered by a particular membrane.

The fibres are, for the most part, ranked in fasciculi, in a lateral situation with respect to each other, and distinguished by membranous, cellular, or adipose septa, as by so many particular vaginae.

These fibres are connected to each other, and to the intermediate septa, by a great number of very small fine-filaments, the capillary extremities of arteries, veins, and nerves running over them; and they are inclosed in a thin membranous, cellular covering, called the proper membrane of the muscle, being a continuation of the septa or vaginae already mentioned.

The disposition of the fibres is various: some are disposed like radii; others form planes more or less incurvated; and some form complete circumferences, the two extremities meeting and uniting together.

The difference of muscles is very considerable, and depends on many circumstances; the chief of which are, the size, figure, direction, situation, structure, connection, and use; and it is from these differences that the names of the greatest part of the muscles are taken.

From

From their size they are termed *great, middle, small, long, broad, thin*: From their figure, *triangular, scalenous, square, &c.* From their direction, *strait, oblique, transverse*. From their situation, *superior, inferior, external, &c.*

With respect to their structure, muscles are either simple or compound. Simple muscles are those whose fleshy fibres, or rather the fleshy portions of their moving fibres, are all uniformly disposed, and terminate in tendons lying either in a strait or oblique line.

Compound muscles are those whose fleshy fibres are disposed obliquely in several particular ranks, representing the same number of simple muscles, with their fibres, lying in opposite directions. In proportion to the number of these ranks or series, the muscle is said to be more or less compounded.

When the compound muscle is made up of two simple muscles only, these are so disposed as to represent a feather, and the compound muscle is from thence termed *penniform*.

Some are made up of two muscles more or less, in a lateral situation with respect to each other, and united at one extremity: others are made up of three or four muscles, situated in the same manner; and if they are united at that extremity which the ancients called the head of the muscle, they are called *bicipites, tricipites, &c.* according to the number of these heads; but if they are joined at the other extremity, they are termed *bicornes, tricornes, &c.*

The muscles are fixed by their extremities to different parts, and in different places of the human body. The greatest part of them are inserted in bones alone. Some are fixed partly to bones, and partly to cartilages; as those of the ear and nose: some partly to bones, and partly to the integuments; as several muscles of the face.

The names taken from the connections and insertions of muscles are generally of two kinds; one common, and referred to some considerable part of the body; as when we say, the muscles of the head, of the thorax, abdomen, &c.; the other proper, specifying more particularly the insertions of each muscle, as the *maстоideus, sterno-mastoideus, &c.*

The general use of the muscles is to move all the parts of the body, whether hard, soft, or fluid. Most of the hard and soft parts are moved by these powers being fixed to them, and they move the rest without any such insertion.

The action of the muscles in general, consists chiefly in the contraction or shortening of their fleshy portion; by which the extremities of the muscle are brought nearer to each other, and consequently the parts are moved to which these extremities are fixed.

The principal phenomena of muscular action are these: The fleshy portion appears harder and more swelled in the time of action than of inaction, as may be readily perceived by touching it in both states: The hardness of this swelling increases in proportion as the motion is continued, as is likewise evident by the touch; and it likewise increases by merely adding to the weight or resistance of the part moved, though its situation does not continue to be changed.

## SECT. II. *The MUSCLES of the Abdomen.*

By the muscles of the abdomen, or lower belly, we mean those which form principally the sides or circumference of that cavity. They are commonly ten in number, five on each side; eight whereof are very large, the other two very small.

### OBLIQUUS EXTERNUS.

The obliquus externus is a broad thin muscle, fleshy on its upper and back-part, and tendinous on the anterior and greatest portion of the lower part. It reaches from half the lateral and inferior part of the thorax, to almost half the lateral and superior part of the pelvis; and from the back-part of the regio lumbaris to the linea alba.

It is fixed, by its upper part, to the ribs; by the lower, to the os ilium, ligamentum Fallopii, and os pubis; and, by the fore-part, to the linea alba. The posterior portion next the vertebræ of the loins has commonly no true muscular insertions.

### OBLIQUUS INTERNUS.

THE internal oblique is a broad thin muscle like the former, having nearly the same extent and insertions; that is, in the lower ribs above; in the crista of the os ilium and ligamentum Fallopii, below; and in the linea alba, before: but it differs from it in this, that its lower part is more fleshy than the upper.

One portion of its lower extremity, which is entirely fleshy, is fixed, by very short tendinous fibres, in the middle space between the two labia of the crista, ossis ilium, from the back-part of the tuberosity of that crista, near the symphysis of the os sacrum, almost all the way to the superior and anterior spine of the os ilium; so that its insertion reaches farther back than that of the external oblique.

The fleshy fibres thus fixed, run up first a little obliquely from behind forward, and then this obliquity increases proportionably as the fibres lie more anteriorly, and they cross those of the fleshy portion of the external oblique, being afterwards inserted exteriorly in the lower edges of the cartilages of all the false ribs, and those of the two lowest true ribs, reaching to the extremity of the cartilago ensiformis.

This muscle is likewise called *obliquus descendens*, for the same reason that the former is termed *ascendens, obliquus inferior*, and *obliquus minor*, because it does not reach so high, and is not quite so large as the external oblique.

### MUSCULI RECTI.

THE recti are long narrow muscles, thicker than the obliqui. They lie near each other like two large bands, from the lower part of the thorax, to the os pubis, the linea alba coming between them. Their breadth diminishes, and their thickness increases gradually from above downward.

The

The superior extremity of each muscle is fixed to a part of the lower extremity of the sternum, to the three lowest true ribs, and to the first false rib, by the same number of digitations, of which that which is farthest from the sternum is the broadest.

The body of the muscle lies in the vagina, formed by the aponeurosis of the broad muscles of the abdomen. Externally, it is divided into several portions, resembling distinct muscles placed endways, by transverse tendons, termed *eneruations*, which commonly are all above the umbilicus, very seldom below it, and they adhere very close to the vagina.

The lower extremity of this muscle is narrower than the upper, and ends in a thin tendon fixed in the internal labium of the upper edge of the os pubis, near the symphysis, and there it touches the tendon of the other rectus.

### MUSCULI PYRAMIDALES.

At the lower part of the recti, we meet commonly with two small muscles, which at first seem to be a portion or appendix of the former. They are named *pyramidales* from their figure; and by Fallopius, *succenturiati*.

At the lower extremity, they are broad and thick, being there fixed to the upper edge of the ossa pubis, immediately before the recti. They decrease gradually in breadth and thickness as they ascend, and end by a point in the linea alba, a little way below the umbilicus.

### TRANSVERSALES.

The transverse muscles are nearly of the same breadth with the obliques. Each of them is fixed to the ribs above; below, to the os ilium, and ligamentum Fallopii; before, to the linea alba; and behind, to the vertebrae.

The upper part of this muscle is fixed to the lower part of the inner surface of the cartilages of the two lowest true ribs, and of all the five false ribs, by fleshy digitations, the fibres of which run more or less transversely toward the linea alba, at some distance from which they become tendinous.

The middle part is fixed to the three first vertebrae of the loins, by a double aponeurosis, or two tendinous planes, one internal or anterior, the other external or posterior.

The inferior part of this muscle is fixed by an insertion wholly fleshy to the internal labium of the crista ossis ilium, and to a great part of the ligamentum Fallopii. From thence many of its fibres run towards the linea alba, the rest to the os pubis, all of them becoming more or less tendinous before their insertion.

### USES OF THE ABDOMINAL MUSCLES.

The common uses are, to sustain the viscera of the abdomen, and to counterbalance the perpetual motions of ordinary respiration, and thereby gently and continually to act on the viscera; which action may be reckoned a

sort of trituration, of great importance to the animal economy. They compress the abdomen, in order to clear it of what ought to pass off by the natural outlets; to relieve the stomach, by vomiting, from whatever might be hurtful to it; and, lastly, to drive out, by a violent expiration, whatever may incommode the organs contained in the thorax.

The muscoli recti serve to support the trunk of the body when inclined backward, and to bend or bring it forward again; to raise the body up when lying; and, lastly, to climb.

The pyramidales seem only to assist the action of the recti; though, when we consider the oblique direction of their fibres toward the linea alba, there may be some reason to think that they compress the bladder, especially when very full of urine.

The transversales seem to have no other use than that of bracing or girding the abdomen in different degrees.

### SECT. III. The MUSCLES which move the Bones of the Shoulder upon the Trunk.

#### TRAPEZIUS.

THE trapezius is a large, broad, thin, fleshy plane, situated between the occiput and lower part of the back, and from thence extending to the shoulder, in the figure of a large irregular square. From this figure the ancient Greeks took its name, and, together with the trapezius of the other side, it forms a kind of lozenge.

Above, it is fixed in the superior transverse line of the os occipitis, by a thin series of fleshy fibres, reaching to the musculus occipitalis, and appearing to cover that muscle by a kind of aponeurosis. Behind, it is fixed to the five superior spinal apophyses of the neck, by means of the posterior cervical ligament, and immediately to the extremities of the two lowest spinal apophyses of the neck, and of all those of the back.

This muscle covers immediately the splenius or mastoideus superior, part of the complexus major, the angularis, rhomboides, and part of the latissimus dorsi.

#### RHOMBOIDES.

THIS muscle is a thin, broad, and obliquely square fleshy plane, situated between the basis of the scapula and the spina dorsi; and it is from its figure that it has been termed *rhomboides*.

It may be divided into two portions, one superior, the other inferior, which sometimes appear separate. The superior portion is fixed, by an insertion wholly fleshy, in the two or three lowest spinal apophyses of the neck, and partly in the posterior cervical ligament. The inferior portion is fixed, by a tendinous plane, in the three or four uppermost spinal apophyses of the back.

These two portions, of which the inferior is by much the broadest, being united, are inserted in the edge of the basis scapulae, from the small triangular space to the inferior angle, the superior portion covering a small part of the insertion of the angularis.

This whole muscle is covered by the trapezius, and covers immediately the serratus posticus superior, being joined to each of these muscles by a filamentary or cellular substance.

#### ANGULARIS, VULGO LEVATOR SCAPULÆ PROPRIUS.

THIS is a long, and pretty thick muscle, about two fingers in breadth, lying above the superior angle of the scapula, along the posterior lateral part of the neck of that bone.

It is inserted above in the extremities of the transverse apophyses of the four first vertebræ of the neck, by four fleshy branches, ending in short tendons; sometimes the second, sometimes the third, or both, and sometimes the fourth of these branches, is wanting; these defects being made up by the largeness of the rest.

From thence these branches run down a little obliquely, and then uniting together, they are inserted in the superior angle of the scapula, and in the edge of its basis, from thence to the small triangular space, being there covered a little by the rhomboides.

This muscle is easily divided into two through its whole length. It is covered by the trapezius, and its insertions in the neck are sometimes mixed with those of the neighbouring muscles.

#### PECTORALIS MINOR.

THIS is a small fleshy muscle, something of a triangular shape, situated at the superior, lateral, and anterior part of the thorax.

By its basis it is inserted in the external labium of the upper edge of the second, third, fourth, and fifth true ribs; near their union with the cartilages, by the same number of digitations or separate fleshy portions, because of the intervals between the ribs; and for that reason it has been called *serratus minor anticus*.

From thence these portions run up, more or less, obliquely toward the shoulder, and form a fleshy belly, which contracts as it passes before the two first ribs, and then becoming a short, flat, and broad tendon, is inserted in the upper part of the apophysis coracoïdes of the scapula, reaching all the way to the point of that process.

This muscle is covered by the pectoralis major, and adheres very closely to the external intercostal muscles.

#### SERRATUS MAJOR.

THIS is a broad, fleshy, and pretty thick muscle, lying on the lateral part of the thorax, between the ribs and scapula, by which it is covered. Its figure is that of an irregular square, its greatest breadth being in the back-part, where it terminates by digitations of unequal lengths, in a radiated disposition, their extremities describing an arch or curve; and from these digitations its name is taken.

It is inserted backward in the internal labium of all the basis of the scapula, from the superior to the inferior angle. From thence running forward wholly fleshy, it

increases gradually in breadth, and is inserted in all the true ribs, and often in one or two of the false ribs, by the same number of digitations.

#### SUBCLAVIUS.

THIS is a small oblong muscle, lying between the clavicle and first rib. It is fixed by one end in all the middle lower portion of the clavicle, at the distance of about an inch from each extremity; and by the other in the cartilage and a small part of the bone of the first rib. It seems likewise to adhere to the extremity of the clavicle next the sternum, by a kind of broad thin ligament.

#### USES of the MUSCLES which move the BONES of the SHOULDER on the TRUNK.

THE mechanism of the scapula, in relation to its motions and changes of situation, is very different from that of all the other bones of the body, except the os hyoides. All the other bones have solid fulcra or fixed points, on which they are either moved or fixed by the muscles; but the motions of the scapula, its changes of situation, and its continuance in any one given attitude, are brought about without the help of any solid fulcrum. The muscles alone sustain it and brace it down, in all its different motions and situations.

The scapula has this peculiarity likewise belonging to it, that it is the fulcrum and basis of all the motions of the os humeri, of some motions of the fore-arm, and even of all the most violent efforts made with these bones, without being itself either moved or fixed on any solid basis.

The use of the trapezius is to raise the shoulder, and to keep it from sinking.

The serratus major raises the shoulder or top of the scapula, brings it forward, and hinders it from sinking. In all these, it is the principal actor; and it is impossible to conceive how labourers raise and support, by the shoulder alone, the heavy burdens with which they are loaded, without the assistance of this muscle.

According to the insertions and direction of the rhomboides, its general use must be, to draw backward and upward the sub-spinal portion of the basis scapulae.

It is likewise a moderator to the trapezius and serratus major, when they raise the shoulder, or carry the acromium upward; and it brings the scapula back to its natural situation, when the action of these muscles ceases.

The angularis, by its insertion in the superior angle of the scapula, moderates the descent of that angle, while the trapezius and serratus major raise the acromium. Afterwards, when these two muscles cease to act, the angularis raises the superior angle, and by that means depresses the acromium.

The pectoralis minor assists the rhomboides and angularis, as moderators of the action of the trapezius and serratus major, in turning the point of the acromium upward, the superior angle downward, and the inferior angle forward.

It is likewise an assistant to the rhomboides and angularis, in restoring the scapula to its natural situation, when

when the trapezius and serratus major cease to act; by drawing downward the apophysis coracoides, in which it is inserted.

The subclavius can have no other ordinary use, but to bring down the clavícula, after it has been raised, together with the acromium, by the action of the trapezius and serratus major.

#### SECT. IV. *The MUSCLES which move the Os Humeri on the Scapula.*

##### DELTOIDES.

THIS is a very thick muscle, covering the upper part of the arm, and forming what is termed the stump of the shoulder. It is broad above, and narrow below, in a triangular form; and its name is taken from the resemblance it bears to the Greek letter  $\Delta$  delta.

It is made up of eighteen or twenty small single muscles, in an opposite situation with respect to each other, and united by middle tendons; so that, taken all together, they form several penniform muscles. The outer surface appears almost wholly fleshy, but on the inner surface we see the several tendons.

Above, it is fixed in the whole inferior labium of the spina scapulae, in the convex or long edge of the acromium, and in the third part of the anterior edge of the clavicle next that apophysis. It surrounds the angle formed by the articulation of these two bones, by a particular slope and fold contrived for that purpose.

From thence it runs down above one third of the length of the os humeri, where it is inserted, by a thick tendon, in the large muscular rough impression below the bony ridge which goes from the great tuberosity of the head of the bone.

##### PECTORALIS MAJOR.

THIS is a large, thick, and fleshy muscle, covering the fore-part of the breast, from the sternum, where it is very broad, to the axilla, where it contracts in its passage to the arm.

The insertions in the sternum end by a great number of very short tendons which run toward the middle of the bone, meeting and decussating those from the same muscle on the other side. The lower insertions are most distinctly digitated, and they mix with those belonging to the rectus and obliquus externus of the abdomen, there being likewise several fasciculi of fibres common to the pectoralis with these muscles. This portion is also fixed to the ribs by internal fleshy strata covered by the external insertions, and forming, together with them, the thickness of the muscle.

From thence all the fleshy fibres contract in breadth, and approach each other, in their passage to the arm. The superior fibres run downward, joining those of the clavicular portion; those next them run less obliquely; the following more or less transversely; and the inferior run upward, in the same manner.

This muscle, together with the deltoides, sends off

an aponeurosis, which, joining that of the biceps, is spread over the muscles of the arm.

##### LATISSIMUS DORSI.

THIS is a broad, thin, and mostly fleshy muscle, lying between the axilla, where it is very narrow, and the back on which it expands itself by radiated fibres, both in length and breadth, from the middle of the back all the way to the lower part of the regio lumbaris; and from this situation it has its name.

Its insertions are partly tendinous, and partly fleshy. In the first place, it is sometimes, but not always, fixed in the inferior costa of the scapula near the angle, by a fasciculus of fleshy fibres. In the next place, it is fixed by an aponeurosis, in the spinal apophyses of the six or seven, and sometimes eight lowest vertebræ of the back, in those of all the vertebræ of the loins, in the superior spines and lateral parts of the os sacrum, and in the external labium of the posterior part of the os ilium.

##### TERES MAJOR.

THIS is a long, thick, flat muscle, situated a little obliquely between the inferior angle of the scapula, and the upper part of the arm.

It is fixed by its posterior fleshy extremity in the large angular surface on the outside of the scapula, in the inferior costa of that bone, and near the angle. From thence it advances with longitudinal fibres toward the upper quarter of the os humeri, terminating in a broad flat tendon intermixed with some fleshy fibres, which at the upper edge are continued all the way to the insertion, lying in the same place with the tendon.

It is inserted, by its anterior extremity, at the lower part of the bony ridge of the small tuberosity, along the edge of the channel, almost opposite to, and sometimes a little lower than the insertion of the pectoralis major. It lines the cavity of the channel by a tendinous elongation, which joins that from the pectoralis, and seems to be continued with it.

##### TERES MINOR.

THIS is a very fleshy muscle, resembling the teres major, but narrower and shorter. It lies above the last named muscle, between the costa inferior of the scapula, and the head of the os humeri.

It is fixed by one end to all the middle part of the inferior costa of the scapula, and to the long particular surface immediately above that costa, reaching from the great angular surface near the neck of the bone. From thence it runs wholly fleshy, till it changes into a flat tendon, which is inserted in the posterior or inferior surface of the great tuberosity of the head of the bone, and likewise a little lower down.

##### INFRA-SPINATUS.

THIS is a triangular, fleshy, and pretty broad muscle. In some measure penniform, filling the whole infra-spinal cavity or fossa of the scapula.

I:

It is fixed in the posterior half of the infra-spinal cavity or fossa, and to the corresponding part of the basis of the scapula.

From thence arise a great number of short fleshy fibres, which run more or less obliquely, and end in a middle tendinous plane, which terminates a little below the broadest part of the spine of the scapula, under the root of the acromium.

Then the fleshy fibres, leaving the bone, unite in one fleshy mass, which, passing under the acromium, over the articulation of the head of the os humeri, and adhering to the capsular ligament, terminates there in a flat broad tendon, which, adhering likewise to the capsula, is afterwards inserted in the greater middle surface of the great tuberosity of the head of the os humeri.

#### SUPRA-SPINATUS.

THIS is a thick narrow muscle, in some measure penniform, filling all the supra-spinal cavity of the scapula.

It is fixed to all the posterior half of the supra-spinal fossa; and sometimes its insertion reaches near the neck of the bone. There the fibres leave the surface of the bone, and pass between the acromium and neck of the scapula, under the arch formed by the acromium and extremity of the clavicle, and under the ligament between the acromium and apophysis coracoides; being afterwards inserted in the superior surface of the great tuberosity of the head of the os humeri, very near the bony channel.

#### CORACO-BRACHIALIS.

THIS is a long muscle lying on the inside of the upper half of the os humeri.

It is fixed above to the point of the coracoid apophysis, between the insertions of the biceps and pectoralis minor, by a tendon, which, as it descends, adheres to a good way to the tendons of these two muscles. Afterwards it becomes fleshy, and is inserted by a broad thin extremity, with a small mixture of tendinous fibres, in the middle part of the os humeri.

#### SUBSCAPULARIS.

THIS muscle is of the same breadth and length with the scapula, of which it occupies all the inner or concave side; and from this situation it has its name. It is thick, and made up of several penniform portions nearly in the same manner with the deltoides.

It is fixed in the internal labium of the whole basis, and in almost the whole internal surface of the scapula; its fleshy portions lying in the intervals between the bony lines, when these are found. Near the neck, they leave the bone, and form a very broad tendon which is inserted in the surface of the small tuberosity of the head of the os humeri.

#### USES of the MUSCLES which move the OS HUMERI on the SCAPULA.

THE deltoides, from the disposition of its insertions in the scapula and clavicle, may raise the arm, or sepa-

rate it from the ribs, not only directly, but likewise obliquely in many different ways. The arm being lifted directly upward, the lateral, anterior, and posterior portions of this muscle may bring the arm, so raised, forward and backward.

The latissimus dorsi serves in general to bring down the arm when raised; it also serves to depress the shoulder, or to maintain it in that situation against any force that endeavours to raise it; as when we lean upon the elbow in sitting, or walk upon crutches.

The pectoralis major serves in general to bring the arm near the ribs, to press it strongly against them, and to carry it towards the fore-part of the thorax.

The teres major, by being inserted in the os humeri in a direction parallel to the latissimus dorsi, becomes a congener to the superior and posterior portion of that muscle; and accordingly moves the os humeri in the same manner with it. It turns the bone round its axis, when the fore-arm is carried behind the back.

It likewise pulls the arm directly backward, without moving it round its axis.

The coraco-brachialis brings the arm to the fore-side of the thorax, raising it at the same time; and, in this case, it may be reckoned a congener or assistant to the pectoralis major in great efforts; and may perform the same motion by itself, when no great force is necessary; as when the whole arm hangs down, and is moved backward and forward like a pendulum, the motion forward being performed by the coraco-brachialis, and the motion backward by the teres major, its antagonist.

This muscle may likewise move the scapula on the os humeri kept firmly depressed, as when sitting in a chair we take fast hold of the edge of it with the hand. In this case the coraco-brachialis may bring the acromium downward, and the inferior angle of the scapula, near the vertebræ. It serves likewise to bring the arm to its former situation, after it has been turned by the latissimus dorsi, in order to apply the hand to the back; and then it turns the os humeri upon its axis in a contrary direction to that given it by the other muscle.

The supra-spinatus joins with the deltoides in lifting up the arm; this muscle beginning that action, and the deltoides continuing it.

The infra-spinatus being inserted by its tendon in the middle surface of the great tuberosity of the os humeri, must perform different motions according to the different situations of that bone. If it acts while the arm hangs down, parallel to the trunk of the body, it may move the os humeri round its axis, from before outward; and consequently, if the fore-arm be at the same time bent, it will turn the hand from the body, &c.

When the arm hangs down in its natural situation, the subscapularis may turn it round its axis, from without forward, as it happens when in this situation we beat the breast with the fore-arm bent; and it likewise strongly assists the latissimus dorsi, when we turn the hand behind the back.

When the arm being raised, we move it backward, as in giving a back-stroke with the elbow or fist, the subscapularis hinders the head of the os humeri from being laxated forward.

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The *teres minor* may turn the arm when depressed round its axis, from before outward; as it happens when the fore-arm, being bent and applied to the lower part of the breast, is removed from thence, without moving the elbow from the side.

SECT. V. *The MUSCLES which move the Bones of the Fore-arm on the Os Humeri.*

**BICEPS** *for* CORACO-RADIALIS.

THIS is a double muscle made up of two long fleshy bodies, more or less round, lying by the side of each other, on the middle anterior part, and a little toward the inside of the arm. These two bodies are separated above, each of them ending in a small tendon. As they run down they become contiguous, and afterwards closely united by one common broad tendon.

It is fixed by one of the superior tendons, in the apex of the coracoid apophysis of the scapula.

The other superior tendon is smaller and longer than the former, and the fleshy body belonging to it shorter and more compounded. This tendon is lodged in the bony channel of the os humeri, being surrounded by a membranous vagina continued from the capsular ligament, and ending at the fleshy body where it is entirely closed.

**BRACHIÆUS.**

THIS is an oblong, thick, and broad muscle, lying immediately on the anterior part of the lower half of the os humeri. The upper part of it is forked or sloped, and at the bending of the joint of the elbow the lower part contracts.

It is fixed to the surface of the os humeri by a great number of fleshy fibres, from the lower insertion of the deltoides, almost down to the two fossæ at the lower extremity of the bone, and from one edge of the fore-side of this lower extremity to the other. The fibres are for the most part longitudinal, those nearest the surface of the muscle being longest, the more internal growing gradually shorter.

**ANCONÆUS MAJOR.**

THIS is a long fleshy muscle lying on the backside of the os humeri.

It is fixed above by a short tendon to the inferior impression in the neck of the scapula, and to a small part of the inferior costa of that bone. From thence it passes between the extremities of the subscapularis and *teres minor*, and, having reached the backside of the lower extremity of the os humeri, it ends obliquely in a strong broad tendon, which, adhering closely in the capsular ligament, is afterwards fixed by a broad insertion in the rough tuberosity on the upper side of the olecranon.

**ANCONÆUS EXTERNUS.**

THIS is a long muscle lying on the outer part of the

backside of the os humeri, from its neck to the external condyle.

It is fixed above in the neck of the os humeri under the inferior surface of the great tuberosity, and under the insertion of the *teres minor*, but a little more backward. It is likewise fixed by some oblique fibres in the external inter-muscular ligament.

**ANCONÆUS INTERNUS.**

THIS muscle is shorter and more fleshy than the *anconæus externus*, and lies toward the inner part of the lower half of the os humeri.

It is fixed above, under the lower extremity of the *teres major*, but a little more backward, and to the internal inter-muscular ligament, which makes a kind of septum between this muscle and the *brachizus*. From thence the fibres contracting in breadth, pass toward the tendon of the *anconæus major*, some of them running in between it and the bone, and are inserted in the edge and inner side of that tendon.

**ANCONÆUS MINOR.**

THIS is a small muscle obliquely triangular, lying in the oblong fossula on the outside of the olecranon.

It is fixed by a small, but pretty strong tendon, in the lower part of the external condyle of the os humeri. From thence the fleshy fibres run down obliquely in a radiated form, and are inserted in the bottom and whole posterior edge of the fossula already mentioned.

*Uses of the Muscles which move the Bones of the Fore-arm on the Os Humeri.*

THE *biceps*, or *coraco-radialis*, bends both bones of the fore-arm, and turns the radius upon the ulna; performing both motions by its insertion in the radius alone. It likewise moves the os humeri on the fore-arm, the scapula on the os humeri, and the os humeri on the scapula.

The *brachizus* serves to bend the fore-arm on the os humeri, by its insertion in the ulna, and by the connection of that bone with the radius. It serves also to move the os humeri on the fore-arm.

The *anconæus maximus* serves to extend the fore-arm, by bringing the ulna to a straight line with the os humeri. It serves likewise to extend the os humeri on the ulna, when the last named bone is fixed by some exterior resistance, as when, being laid upon the ground, we rise by supporting ourselves on our hand. In this case likewise, the scapula must be kept steady by the *coraco-brachialis*.

The two lateral *anconæi* co-operate with, and assist the *anconæus maximus*, in extending the fore-arm on the os humeri, and the os humeri on the fore-arm.

The *anconæus minimus* may concur with the other muscles of that name, in extending the fore-arm on the os humeri, and the os humeri on the fore-arm; but its action does not reach to all the degrees of flexion of these bones; for when the fore-arm is very much bent, if we

examine

examine carefully the situation of this muscle, we will find it more disposed to maintain these bones in that posture, by co-operating with the brachialis, than to extend them by assisting the other anconæi.

the other in the broad concave side of the lower extremity of the radius.

It has a ligamentary or tendinous frænum belonging to it, one end of which is fixed in the interosseous ligament, the other in the inner edge of the basis of the radius.

### SECT. VI. *The MUSCLES which move the Radius upon the Ulna.*

### *The Uses of the Muscles which move the Radius on the Ulna.*

#### SUPINATOR LONGUS *five* MAJOR.

THIS is a long flat muscle, lying on the external condyle of the os humeri, and on the convex side of the radius from one end to the other.

It is fixed by fleshy fibres to the external inter-muscular ligament, and to the crista of the external condyle of the os humeri, for five or six fingers breadth above the condyle, between the brachizus and anconæus externus. From thence it runs along the whole convex side of the radius, and is inserted by a flat narrow tendon, a little above the styloid apophysis in the angle between the concave and flat sides of the extremity of this bone.

THE supinator longus assists in the motion of supination, and is also a flexor of the fore-arm.

The supinator brevis seems to have no other use than what is expressed by its name; and as it is a short small muscle, it must be very weak.

The pronator teres can have no other action but that of pronation, in the different situations of the radius, whether that bone be in a middle state between pronation and supination, or in the greatest degree of supination; and, in this case, though it is but a small weak muscle, it overcomes the supinator longus.

The pronator quadratus is capable of no other motion but pronation, and it acts with much more force than its congener the pronator teres.

#### SUPINATOR BREVIS *five* MINOR.

THIS is a small thin fleshy muscle, surrounding a great portion of the upper third part of the radius.

It is fixed by one end to the lower part of the external condyle of the os humeri, to the external lateral ligament of the joint, to the annular ligament of the radius, and to part of the lateral eminence in the head of the ulna.

From thence it passes obliquely over the head of the radius, covering some part of it; and running down upon, and in some measure surrounding the neck, it turns in under the bicipital tuberosity, and is inserted by the side of the interosseous ligament in the inside of the superior quarter of the bone, and even a little lower.

### SECT. VII. *The MUSCLES which move the Carpus upon the Fore-arm.*

#### ULNARIS.

THIS is a long muscle, fleshy at its upper extremity, and tendinous at the other, situated on the outer part of the ulna.

It is fixed by its upper part in the backside of the long or internal condyle of the os humeri, in that part of the olecranon which is next the condyle, along the upper half of the ulna very nearly; and to the middle common tendon of the neighbouring muscle, termed commonly *profundus*.

It runs in the direction of the external angle of the ulna, and ends by a long tendon, in the os pisiforme or orbiculare of the carpus, reaching likewise to the os unciforme, being united to the ligament common to these two bones.

#### PRONATOR TERES *five* OBLIQUUS.

THIS is a small muscle, broader than it is thick, situated on the upper part of the ulna opposite to the supinator brevis.

It is fixed to the internal condyle of the os humeri, partly by fleshy fibres, and partly by a tendon common to it with the ulnaris internus. From thence it passes obliquely before the extremity of the tendon of the brachizus, and reaches to the middle part of the convex side of the radius, where it becomes flat, and is inserted below the supinator brevis by an extremity almost wholly fleshy.

#### PRONATOR QUADRATUS *five* TRANSVERSUS.

THIS is a small fleshy muscle nearly as broad as it is long, lying transversely on the inside of the lower extremity of the fore-arm.

It is fixed by one side or edge in the long eminence at the lower part of the internal angle of the ulna, and by

#### RADIALIS INTERNUS.

THIS is a long muscle very like the foregoing, but situated more obliquely.

Its fleshy portion is fixed, by a short tendon, to the outer and upper side of the inner condyle of the os humeri. From thence it passes obliquely toward the radius; and running along about two thirds of that bone, it forms a long tendon, which passes under a particular annular ligament, and under the insertion of the musculus thenar.

This tendon is at length inserted chiefly in the inside of the basis of the first metacarpal bone, and often in the second likewise, and a little in the first phalanx of the thumb, having first passed through the channel of the os trapezium, which sustains the thumb.

#### ULNARIS.

## ULNARIS EXTERNUS.

THIS is a long muscle lying on the outside of the fore-arm, fleshy toward the os humeri, and tendinous toward the carpus.

It is fixed above to the external condyle of the os humeri, being there united to the anconæus minor, to the annular ligament of the head of the radius, and to the upper half of the external angle of the ulna. From thence it advances, and forms a tendon, which passes through the external notch at the lower extremity of this bone, on one side of the styloid apophysis.

The tendon, having afterward passed under a particular ligament situated near the os cuneiforme of the carpus, is inserted in the outside of the basis of the fourth metacarpal bone, sending some tendinous filaments to the basis of the little finger.

## RADIALIS EXTERNUS, PRIMUS &amp; SECUNDUS.

THESE are two muscles closely united together, lying along the external angle of the radius, between the os humeri and the carpus, being fleshy near the former, and tendinous near the latter.

The first is inserted above, in the crista of the external condyle of the os humeri, below the insertion of the supinator longus. The second is inserted in the same condyle below the insertion of the first; and in the neighbouring articular ligament. From thence the two fleshy bodies run down very close together; and having reached the middle of the outside of the radius, each of them terminates in a long tendon.

The two tendons accompany each other to the extremity of the radius; and, having passed under a particular annular ligament, they are divided as it were into two cornua; from whence the ancients, who looked upon them as one muscle, gave it the name of *bicornis*.

One of these tendons is inserted anteriorly in the basis of the first metacarpal bone, the other nearly in the same place of the second bone.

## ULNARIS GRACILIS, vulgo PALMARIS LONGUS.

THIS is a small muscle, lying between the os humeri and the carpus, on the inside of the fore-arm; its body being small and slender, its tendon very long and flat.

It is fixed by its fleshy portion, in the small crista of the inner condyle of the os humeri, sometimes closely united to the ulnaris internus. From thence it runs down fleshy for some space, turning a little obliquely towards the middle of the fore-arm, and ends in a long, narrow, thin tendon.

This tendon passes down the middle of the fore-arm, over all the other muscles to which it slightly adheres, and advancing over the large internal annular or transverse ligament of the carpus, is inserted in the surface thereof, sending off some radiated filaments to the aponeurosis palmaris.

## PALMARIS CUTANEUS.

THIS muscle is a small thin plane of fleshy fibres, situated transversely, or more or less obliquely, under the

skin of the large eminence in the palm of the hand, between the carpus and the little finger; its fibres adhering to the skin, and being in some measure interwoven with the membrana adiposa.

These fibres are fixed along the edge of the aponeurosis palmaris, from the large ligament of the carpus toward the little finger; and they run in for some space on the plane of the aponeurosis, but without any connexion with the bones of the metacarpus. Near the aponeurosis, these fibres are more or less tendinous, and some of them often cross each other.

## METACARPIUS.

THIS is a very small fleshy muscle, situated obliquely between the large internal annular or transverse ligament of the carpus, and the whole inside of the fourth metacarpal bone.

It is fixed by a small short tendon to the os orbiculare, and to the neighbouring part of the large ligament of the carpus. From thence its fibres run more or less obliquely toward the inside of the fourth metacarpal bone, in the outer edge of which they are inserted. The fibres of this muscle are of unequal lengths, and extend all the way to the articulation of the first-phalanx of the little finger with the fourth metacarpal bone, but they have no manner of relation to that finger.

## USES of the Muscles which move the Carpus on the Fore-arm.

WHEN the ulnaris internus acts alone, or as the principal mover, it brings the hand obliquely toward the internal condyle, and toward the olecranon, though with difficulty.

When it acts together with the radialis internus, it turns the hand equally towards the two extremities of the bones of the fore-arm; and thereby moves not only the carpus in general on the fore-arm, but also the second row of the carpus on the first, and the metacarpal bones on the second.

When it acts with the ulnaris externus, it turns the outer edge of the hand toward the olecranon.

When the ulnaris externus acts with the ulnaris internus, it turns the outer edge of the hand toward the olecranon, as already said.

With the radiales externi, it turns the back of the hand toward the outer condyle.

When this muscle acts alone, it brings the outer edge of the hand obliquely toward the olecranon and the external condyle at the same time.

With the radialis externus, the internus carries the inner edge of the hand, or that next the thumb, toward the extremity of the radius, and toward the fold made by the ulna and os humeri.

Alone, it moves that part of the hand which is next the thumb obliquely, toward the internal angle of the radius.

The radialis externus, together with the radialis internus, turns the inner edge of the hand directly toward the styloid apophysis of the radius.

With

With the ulnaris externus it inverts the hand, turning the convex side of the metacarpus toward the lower extremity of the bones of the fore-arm. It likewise moves the second row of the carpus on the first.

This muscle, acting alone, draws obliquely, and toward the external angle of the radius, that portion of the hand which answers to the first metacarpal bone, and to the index.

The ulnaris gracilis, commonly called *palmaris longus*, seems to be an assistant to the ulnaris and radialis interni in bending the wrist; and it seems likewise particularly to assist the radialis internus in the motion of pronation.

The metacarpus serves to turn the fourth bone of the metacarpus toward the thumb, and at the same time to increase the convexity of the back of the hand, which is called making *Diogenes's cup*. The fourth bone thus moved carries the third along with it by reason of their connection, which still augments the hollow on one side, and the convexity on the other.

### SECT. VIII. *The MUSCLES which move the Fingers.*

#### FLEXOR POLLICIS LONGUS.

THIS is a long muscle, fixed by short and oblique fleshy fibres to the inside of the upper part of the interosseous ligament, near the radius, and along that bone all the way down to the pronator quadratus. There it terminates in a flat tendon.

This tendon having passed under a particular ligament, runs in between the two portions of the thenar, and then into a sort of groove left between the two sesamoid bones fixed to the basis of the second phalanx of the thumb, on that side which is turned to the palm of the hand. Afterwards the tendon ends in the flat side of the third phalanx, near its basis. It is inclosed in a ligamentary vagina, from the annular ligament to its insertion, and it is divided or slit, so that it appears to be inserted by two extremities adhering together by their edges.

#### EXTENSORES POLLICIS.

THESE are two very distinct muscles, the first or longest of which is sometimes more, sometimes less, and sometimes altogether divided into two, in which case these muscles are three in number. They are situated obliquely between the ulna and convex side of the thumb.

The extensor primus is a long muscle, more or less double, in the manner already said. It is fixed above by fleshy fibres, first to the outside of the ulna, near its upper extremity, below the anconæus minor and insertion of the ulnaris externus; next, to the interosseous ligament under the supinator brevis; and, lastly, to the middle part of the outside of the radius.

From thence it runs down and passes anteriorly over the lower part of the radius, and tendons of the supinator longus and radialis externus, and being gradually di-

vided, it terminates in two long flat tendons, more or less subdivided, which pass together under a particular annular ligament, being only parted by septa or fræna belonging to that ligament.

The first of these two principal tendons is inserted in the edge of the basis of the first phalanx, near the large transverse ligament of the carpus. When this tendon is subdivided, the other portion of it is fixed in that bone of the carpus which sustains the thumb. The other principal tendon, which often belongs to a muscle entirely distinct from the former, is fixed in the convex side of the basis of the second phalanx, where it joins the tendon of the extensor secundus.

The extensor secundus is shorter than the first. It is fixed to the ulna, below the former, and above the insertion of the extensor indicis proprius, and likewise to the neighbouring part of the interosseous ligament. From thence it runs down obliquely on the middle part of the radius, where it has likewise a small adhesion. Afterwards it passes through the small channel in the styloid apophysis of the radius, through the annular ligament belonging to the tendons of the radialis externus, and over these tendons, being parted from them by a small ligamentary septum. It is inserted in the convex part of the third phalanx, near its basis.

#### THE NAR.

THIS is a very thick fleshy muscle, in some measure pyriform, lying on the first phalanx of the thumb toward the palm of the hand, the large eminence in which is chiefly formed by it.

It is fixed to the bone which supports the thumb, and to the neighbouring part of the great internal annular ligament of the carpus. It is in some measure bicipital, two distinct portions answering to the two insertions already mentioned. As it runs along the first phalanx, these two portions unite, and, diminishing in thickness, are both inserted by one tendon in the lateral internal part of the head of the first phalanx, in the lateral part of the basis of the second, and in the lateral ligament of that joint.

#### MESOTHENAR.

THIS is a flat, and nearly triangular muscle, lying between the first phalanx of the thumb, and the bottom of the palm of the hand.

It is inserted, by a very broad basis, in the ligament which connects the os magnum of the carpus to that which supports the thumb. It is likewise inserted along the internal or angular part of that bone of the metacarpus, which supports the middle finger, and in the small extremity of that which answers to the index.

From thence the fibres contracting to an angle, terminate in a flat tendon of different breadths, which is inserted in that side of the head of the first phalanx of the thumb which is turned to the hollow of the hand, and in the neighbouring part of the basis of the second phalanx, by means of the second sesamoid bone belonging to that joint.

ANTITHE NAR

*ANTITHENAR sive SEMI-INTEROSSEUS POLLICIS.*

THIS is a small, flat, fleshy muscle, situated obliquely between the first phalanx of the thumb, and first bone of the metacarpus.

It is fixed by one end toward the basis of the first metacarpal bone, near the first bone of the second row of the carpus. From thence it runs obliquely toward the head of the first phalanx of the thumb, and is inserted in the lateral external part of that bone, or on that side which is turned to the first metacarpal bone. It crosses over the semi-interosseus indicis, this muscle lying toward the back of the hand, and the antithenar toward the palm.

*PERFORATUS vulgo SUBLIMIS.*

THIS is a muscle of a considerable volume, lying along the inside of the fore-arm, fleshy for the greatest part near the articulation of the fore-arm with the os humeri, and near the carpus, terminating in four distinct portions, which become the same number of long small tendons. The name of *sublimis* has been given to it, because it lies almost on the surface of the fore-arm; and that of *perforatus*, from the slits found near the extremities of its tendons.

It is commonly made up of four muscles, closely united by their fleshy portions. It is fixed above to the superior internal parts of the ulna and radius, and to that of the interosseus ligament. A little below the middle of the fore-arm, this large fleshy body is divided into four distinct muscles, which, on the lowest quarter of the fore-arm, end in four flat tendons of different sizes.

These four tendons are inclosed in a common membranous or mucilaginous vagina, which likewise furnishes each tendon with a particular thin vagina. In this manner they advance to the carpus, and pass under the large annular transverse ligament. Beyond this ligament, they spread again in the palm of the hand, still retaining their particular vaginæ, and run between the aponeurosis palmaris and metacarpus, toward the fingers, separating more and more by degrees.

Having reached the heads of the metacarpal bones, they pass under the four arches or fræna formed by the furce of the aponeurosis palmaris, and particular septa of the great transverse ligament of the palm of the hand; and then each tendon having got beyond the head of one metacarpal bone, and beyond the basis of the first phalanx, enters the ligamentary vagina on the flat or inner side of that phalanx, and is inserted in the flat side of the second phalanx, near its basis, the membranous vagina accompanying it to its insertion.

In passing along the inside of the first phalanx, the tendon is divided by a long slit, which gives passage to a tendon of the perforans; and from thence the names of these two muscles are taken.

*PERFORANS vulgo PROFUNDUS.*

THIS muscle is very like the former, and is situated much in the same manner; only it lies lower, and is covered by the perforatus. It is composed of four muscles, which at first seem to make but one mass, and afterwards terminate in four tendons.

The fleshy portions of the first and largest, and also of the second, are fixed in the superior parts of the ulna and interosseus ligament, down to their middle; the fleshy portion of the third is joined to the tendon of the ulnaris internus, by a sort of common aponeurosis; and that of the fourth is fixed along the ulna.

The four tendons have often several small collateral tendons, sometimes five in number, united to the tendons of the neighbouring muscle, as they pass under the large annular ligament of the carpus; but the tendons themselves are separated from the others by thin septa, which form a kind of particular rings. Being thus strengthened, they separate; and running along the palm of the hand in distinct membranous vaginæ, like those of the perforatus, by which they are covered, they enter the ligamentary vaginæ of the first phalanges together with the former; and having passed through the fissures thereof, and through the ligamentary vaginæ of the second phalanges, they are inserted in the flat inner side of the third, near their basis.

THESE four tendons have often several small collateral tendons, sometimes five in number, united to the tendons of the neighbouring muscle, as they pass under the large annular ligament of the carpus; but the tendons themselves are separated from the others by thin septa, which form a kind of particular rings. Being thus strengthened, they separate; and running along the palm of the hand in distinct membranous vaginæ, like those of the perforatus, by which they are covered, they enter the ligamentary vaginæ of the first phalanges together with the former; and having passed through the fissures thereof, and through the ligamentary vaginæ of the second phalanges, they are inserted in the flat inner side of the third, near their basis.

*EXTENSOR DIGITORUM COMMUNIS.*

THIS is a compound muscle, very much resembling the perforatus and perforans, lying on the outside of the fore-arm, between the ulnaris externus and radialis externus.

It is fixed above, by a tendinous extremity, to the posterior and lower part of the external or great condyle of the os humeri, and, by a tendinous adhesion on each side, to the ulnaris and radialis externus. It has likewise sometimes a small insertion in the radius. It is divided into four muscles, like the perforatus and perforans, and four long, slender, small tendons.

Three of these tendons pass through the common external annular ligament of the carpus; and the fourth, which goes to the little finger, passes through a particular ring of the same ligament.

Afterwards these four tendons separate as they go to the fingers, and in their passage communicate with each other, by oblique tendinous series, chiefly near the heads of the metacarpal bones.

Each tendon having reached the basis of the first phalanx, is slightly inserted therein by some lateral expansions fixed in each side of the basis. From thence it advances to the head of the same phalanx, where it is divided into two flat portions, which, at the articulation of the first phalanx with the second, leave some distance between them. About the head of the second phalanx, they unite again, and are fixed in the convex side of the third phalanx, near its basis.

*EXTENSOR INDICIS PROPRIUS.*

THIS is a small long muscle, with a long slender tendon, lying a little obliquely on the lower and outer half of the fore-arm, between the ulna and fore-finger.

It is fixed, by its fleshy body, a little higher than the lowest

lowest third part of the outside of the ulna, below the insertion of the extensor pollicis, and it has likewise a small adhesion to the interosseus ligament. From thence it runs down, ending in a distinct tendon, without any communications, which having passed through the annular ligament of the extensor communis, afterwards joins that tendon which goes to the index.

#### EXTENSOR MINIMI DIGITI PROPRIUS.

THIS is a kind of collateral or auxiliary muscle of the extensor communis, of which it appears almost always to be more or less a portion.

It is fixed along the superior external half of the ulna, from whence its long small tendon runs down in company with the fourth tendon of the extensor communis, all the way to the little finger, where it joins it, and is inserted with it.

#### LUMBRICALES.

THESE are four very small slender muscles, lying in the hollow of the hand, in the same direction with the perforatus and perforans.

They are fixed, by their fleshy bodies, to the tendons of the perforatus on the side next the thumb, near the large annular ligament of the carpus. Near the heads of the metacarpal bones, they become very thin tendons, which accompany those of the perforans through the furcæ of the aponeurosis palmaris. Then they pass on to the same sides of the first phalanges, and join the tendons of the extensor communis; each of them being connected with the nearest portion thereof, at the articulation of the first phalanx with the second.

#### INTEROSSEI.

THESE are small muscles, lying between the metacarpal bones, and filling the three interstices left between them, both exteriorly, or towards the back of the hand, and interiorly, or toward the palm of the hand. From this situation they have the name of *interossei*, and have been divided into external and internal. They are commonly reckoned six in number, three external, and three internal.

The first two external interossei are for the most part inserted in the middle finger. They fill the interstices between the three first metacarpal bones, and surround the middle bone all the way to the hollow of the hand. Their tendons are fixed in both sides of the first phalanx, and in both sides of the second tendon of the extensor communis.

The third external interosseus lies in the interstice betwixt the two last metacarpal bones, and is most commonly inserted in the ring finger; its tendon being fixed in that side of the first phalanx farthest from the thumb, and in the corresponding edge of the third tendon of the extensor communis. The fleshy body of this muscle runs in between the two bones toward the hollow of the hand.

The internal interossei are more simple than the former,

and do not lie so much between the bones. The tendon of the first is inserted in the side of the first phalanx of the fore-finger, next the little finger, and in the corresponding edge of the extensor communis. The tendon of the second goes in the same manner to the side of the ring-finger next to the thumb; and the third, to the same side of the little finger.

There are therefore two external interossei for the middle finger, one for the ring finger, but none for the fore and little finger. The middle finger has no internal interosseus; but the index, ring finger, and little finger, have each of them one.

#### SEMI-INTEROSSEUS INDICIS.

THIS is a small, short, flat, fleshy muscle, very like the antithenar, or internal semi-interosseus of the thumb. It is situated obliquely on one side of that of the thumb, between the first phalanx thereof, and the first metacarpal bone.

It is fixed by one end to the outside of the basis of the first phalanx of the thumb, and a little to that bone of the carpus by which this phalanx is supported; and by the other end it is fixed near the head of the first phalanx of the index, on that side next the thumb.

#### HYPOTHENAR MINIMI DIGITI.

THIS is a small and pretty long muscle, lying on the backside of the fourth metacarpal bone opposite to the thumb, where, together with the metacarpus, or hypothenar metacarpi, it forms that large eminence over-against the thenar or that of the thumb.

It is fixed by one end in the os orbiculare of the carpus, and a little to the neighbouring part of the large annular ligament. The other end terminates by a short flattish tendon, fixed to that side of the basis of the first phalanx of the little finger which is turned from the thumb.

#### Uses of the Muscles which move the Fingers.

THE perforatus serves to bend the second phalanges of all the fingers except the thumb; and the particular muscles, of which it is made up, may act separately, by reason of their distinct insertions in these phalanges.

They not only bend the second phalanges on the first, but also the first on the metacarpal bones, and the metacarpus and carpus on the fore-arm.

The perforans bends particularly the third phalanges in which it is inserted; and by the same motion it may likewise bend the first and second phalanges.

It may likewise be esteemed an assistant to the ulnaris and radialis interni in great efforts; and these muscles may reciprocally be looked upon as assistants to the perforatus and perforans.

The extensor digitorum communis serves to extend the four fingers, to keep them in any degree of extension, and to moderate their flexion in all the determinate degrees of action of the perforatus and perforans.

Each tendon serves to extend a whole finger, that is, all

all the three phalanges together; and likewise each phalanx by itself, though not with the same facility.

The proper extensors of the fore and little fingers are assistants to two subaltern muscles of the extensor communis that go to these fingers, which consequently we extend separately with more ease than either of the other two. These muscles likewise serve to bring the fingers, in which they are inserted, near the other fingers.

The flexor pollicis longus serves chiefly to bend the third phalanx of the thumb, in which it is inserted by the extremity of its tendon. It likewise bends the second phalanx, by virtue of the ligamentary vagina, through which it passes, as through an annular ligament.

The first extensor of the thumb alone, when there are three, a portion of the first, when there are but two, serves to draw the first phalanx from the palm of the hand, or to keep it at a distance therefrom.

The second of these muscles when there are three, or the second portion of the first when there are but two, serves to extend the second phalanx on the first.

The third when there are three, or the second when there are but two, extends the third phalanx on the second.

When they act all together, they assist each other by the graduated insertions of their small subaltern tendons.

The thenar, by its insertion in the first phalanx of the thumb, serves to draw it from the first bone of the metacarpus, more or less directly, as one of its portions acts more than the other, or as they both act equally.

By the insertion of the large portion in the basis of the second phalanx, by the intervention of the sesamoid bone of the same side, it may bend this phalanx laterally on the first, and thereby bring the thumb to a greater distance from the index.

The mesothenar moves the first phalanx of the thumb towards the hollow of the hand, more or less obliquely, as it acts either alone or with the large portion of the thenar, or even with the antithenar. By its insertion in the sesamoid bone of the second phalanx, it likewise moves that phalanx on the first, and thereby assists the flexor longus.

The antithenar moves the first phalanx of the thumb toward the first bone of the metacarpus, and thereby presses the thumb laterally against the index. This motion becomes more or less oblique by the co-operation of the mesothenar.

The hypothenar minor serves to separate the little finger from the rest; which motion is commonly called *abduction*. It likewise keeps this finger separated in all situations, that is, in all degrees of flexion or extension.

The interossei may have two different uses, according to their different insertion, and the different situations of the fingers in which they are inserted.

In general, they assist the extensor communis by their insertions in the lateral angles of the rhomboidal fissures; for thereby they act like lateral ropes, which, together with the tendons of the extensor, serve to extend the third phalanx of each finger.

By the same lateral insertions they perform the lateral motions of the fingers, that is, they press them all close

against each other, but do not separate them all, nor move each finger in particular toward, or from, the thumb. In a general separation of all the fingers, the interossei move only the middle and ring fingers; the index and little finger being separated by other muscles. In the motions of the fingers toward the thumb, which is termed *adduction*, they act only on three fingers, the middle, ring, and little fingers. In the contrary motion, or abduction of the fingers, they move likewise three, *viz.* the index, middle, and ring fingers.

The uses of the interossei in particular, whether external or internal, may be different in different subjects, according to the variety of their insertions; and therefore in living bodies nothing can be determined about them.

According to the situation in which they have been described, the first and second external interossei perform alternately the adduction and abduction of the middle finger; the third performs the abduction of the ring-finger; that is, moves it toward the little finger.

The first internal interosseus makes the abduction of the index, or moves it toward the middle finger; the second makes the adduction of the ring-finger, by moving it likewise toward the middle finger; and the third performs the adduction of the little finger, or moves it toward the middle finger.

The use of the semi-interosseus indicis is to move the first phalanx of the index, more or less directly, toward the great edge of the metacarpus, by removing it from the middle finger. This motion is not a true adduction of the index toward the thumb.

The lumbricales, by the union of their tendons with those of the interossei, are coadjutors to these muscles, not only in the lateral motions of the four fingers, but also in bending and extending them. In the lateral motions, they co-operate according to their situation in each subject; and it is possible that the variety of their insertions answer to that of the interossei, so that the reciprocal co-operation continues still to be equal.

## SECT. IX. *The MUSCLES which move the Os Femoris upon the Pelvis.*

### PSOAS *five* LUMBARIS INTERNUS.

THIS is a long thick muscle situated in the abdomen on the lumbar region, adhering to the vertebræ of the loins, from the posterior part of the os ilium to the anterior part near the thigh.

It is fixed above to the last vertebra of the back, and to all those of the loins, that is, to the lateral parts of the bodies of these vertebræ, and to the roots of their transverse apophyses. The insertions in the bodies of the vertebræ are by a kind of digitations, and are very little tendinous.

From thence the muscle runs down laterally over the os ilium, on one side of the iliac muscle, and passes under the ligamentum Fallopii, between the anterior inferior spine of the os ilium, and that eminence which from its situation may be termed *ilio-pesteina*.

Before

Before it goes out of the abdomen, it unites with the iliacus, and is sometimes fixed, by a few fleshy fibres, in the outside of the eminence last mentioned. It afterwards covers the fore-side of the head of the os femoris, and is inserted in the fore-part of the little trochanter by an oblique tendon, which is folded double from behind forward.

### ILIACUS.

**THIS** is a broad thick muscle, lying on the whole inside of the os ilium.

It is fixed by fleshy fibres to the internal labium of the crista ossis ilium, to that of the slope between the two anterior spines, to the insides of these spines, to the superior half of the inside of this bone, and to the neighbouring lateral part of the os sacrum.

All these fibres, contracting by degrees, run obliquely towards the lower part of the musculus psoas, uniting therewith, and being fixed, by a kind of aponeurosis to the outside of its tendon all the way to the little trochanter. They cover the head of the os femoris, and some of the lowest are inserted in that bone a little above and behind the little trochanter, and others a little lower down.

The iliacus and psoas, thus united, pass under the ligamentum Fallopii, over the slope or channel, between the anterior inferior spine of the os ilium and eminentia ilio-pectinea, in a sort of ligamentary capsula very smooth and polished.

### PECTINEUS.

**THIS** is a small, flat, and pretty long muscle, broad at the upper part, and narrow at the lower, situated obliquely between the os pubis and upper part of the os femoris.

It is fixed above by fleshy fibres to all the sharp ridge or crista of the os pubis, and to a small part of the oblong notch or depression on the fore-side of that crista, in which the upper extremity of this muscle is lodged.

From thence it runs down obliquely towards the little trochanter, under and a little behind which, it is inserted obliquely by a flat tendon, between the superior insertion of the vastus internus, and inferior insertion of the triceps secundus, with which it is united.

### GLUTEUS MAXIMUS.

**THIS** is a thick broad muscle, lying on the outside of the os ilium and upper part of the os femoris.

It is fixed wholly fleshy to all the lateral posterior parts of the os coccygis and os sacrum; to the ligamentum sacro-sciaticum; to the outside of the tuberosity of the os ilium; and from thence to the external labium of the crista of that bone all the way to its highest part, where this muscle mixes fibres with the glutæus medius.

It is likewise fixed to the inside of the fascia lata, at the places which answer to all the insertions already mentioned, but through a much greater space, and by a

very great number of fleshy fibres, almost in the same manner as we shall see in the external plane of the musculus temporalis. The fibres which end in this fascia become gradually shorter, as they are situated lower.

All these fibres contract in breadth in a radiated manner as they approach to the great trochanter, and afterwards form a strong, flat, pretty broad tendon, about an inch in length, which is inserted a finger's breadth or a little more below the great trochanter, in all that large longitudinal impression at the upper part of the linea aspera on the back-side of the os femoris, between the vastus externus and largest portion of the triceps.

### GLUTEUS MEDIUS.

**THIS** is a radiated muscle, almost in the shape of a spread fan. It is pretty thick, and almost as broad as the whole outside of the os ilium, being situated between the crista of that bone and the great trochanter, and covered anteriorly by the fascia lata, and posteriorly by the glutæus maximus.

It is fixed above by fleshy fibres to all that space on the outside of the os ilium, which lies between the external labium of the crista, and the semicircular impression which goes between the superior anterior spine, and the great posterior sinus.

It is likewise fixed in the edge of that ligament which goes between the lower part of the os sacrum and os ilium. Lastly, the inner part of it, which is covered only by the fascia lata, is inserted in the inside of that fascia in the same manner as the glutæus maximus.

From thence all the fibres contract in breadth, more or less, in a radiated manner, as they advance toward the great trochanter, and form a short thick tendon, which mixes a little anteriorly with the tendon of the glutæus minimus; and the most posterior fibres gradually join the side of the tendon of the pyriformis.

The tendon is inserted in the upper convex part of the great trochanter, from the apex of the large superior external rough surface, all the way to the anterior rough surface, encompassing in a manner all that part of the trochanter.

### GLUTEUS MINIMUS.

**THIS** is a small, broad, radiated muscle, situated on the outside of the os ilium, under the other two glutæi.

It is fixed above in all that portion of the outside of the os ilium, which lies between the great semicircular line, and another small one, a little above the supercillium of the cotyloid cavity or acetabulum, running between the anterior inferior spine and the great posterior sinus. It is likewise fixed in the edge of that sinus, in the spine of the ischium, and in the orbicular ligament of the joint of the hip.

From thence its fibres, contracting in breadth, form a short tendon, by which the muscle is inserted in the anterior part of the upper edge of the great trochanter, above the great external convex rough surface in which the glutæus medius is fixed.

### TRICEPS



## TRICEPS PRIMUS.

THIS, with the two following tricipital muscles, are fleshy and flat, and of different lengths, situated between the os pubis and the whole length of the os femoris. The first and second cross each other in such a manner, as that the muscle, which is the first on the os pubis, becomes the second on the os femoris; and the second on the os pubis, is the first on the os femoris. The third muscle keeps its rank.

The triceps primus is fixed above by a short tendon to the tuberosity or spine of the os pubis, and to the neighbouring part of the symphysis, its fibres mixing a little with those of the pectineus. From thence it runs down, increasing in breadth, and is inserted by fleshy fibres anteriorly in the middle portion of the linea femoris aspera.

At the lower part of this insertion, a portion of the muscle separates from the rest, and sends off a long tendon, which, together with a like tendon from the triceps tertius, is inserted in the inner condyle of the extremity of the os femoris.

## TRICEPS SECUNDUS.

THIS muscle is fixed above by fleshy fibres, below the superior insertion of the triceps primus, in all the outside of the inferior ramus of the os pubis, as low as the foramen ovale, but seldom so low as the ramus of the os ischium.

From thence it runs down, and is inserted in the upper part of the linea aspera, between the pectineus and triceps primus, mixing a little with each of these muscles.

## TRICEPS TERTIUS.

THIS muscle is fixed above by fleshy fibres to the anterior part of all the short ramus of the ischium, and to a small part of the tuberosity of that bone.

From thence it runs down, and is inserted by fleshy fibres in the linea aspera, almost from the little trochanter, down to the middle of the os femoris. It goes lower down than the first triceps, sending off a separate portion like that of the muscle last mentioned.

These two portions join together, and form a common tendon, which, running down to the lower extremity of the os femoris, is inserted in the back part of the tuberosity of the inner condyle.

PYRIFORMIS *sive* PYRAMIDALIS.

THIS is a small oblong muscle, of the figure of a flat pear or pyramid, from whence it has its name. It is situated almost transversely, between the os sacrum and ischium, being covered and hid by the first two glutæi.

It is fixed to the inferior lateral part of the os sacrum, by fleshy fibres, and to the neighbouring part of the anterior or concave side of that bone, by three digitations lying between the anterior holes. It is likewise fixed by

a small insertion to the ligamentum sacro-sciaticum and edge of the great sinus of the os ilium.

From thence it runs transversely towards the joint of the hip, its fibres contracting in breadth, and ends in a small tendon, which is inserted in the middle of the internal labium of the upper edge of the great trochanter, by two or three branches.

## OBTURATOR INTERNUS.

THIS is a flat muscle, almost triangular, situated in the bottom of the pelvis. It covers the foramen ovale, and almost all the inside of the os pubis and ischium.

It is fixed to the internal labium of all the anterior half of the foramen ovale, a little to the neighbouring part of the obturator ligament; and also both above and below the foramen. It is likewise fixed to the upper half of the inside of the os ischium from the upper oblique notch in the foramen ovale, to the superior part of the great posterior sinus of the os ilium.

From all this extent the fleshy fibres, contracting in breadth, run down below the spine of the ischium, where they go out of the pelvis through the posterior notch of the ischium, and afterwards unite in one large flat tendon, which crossing over that of the pyriformis, unites with it, having first received on each side some additional fleshy fibres from the two gemelli.

## GEMELLI.

THESE are two small, flat, narrow muscles, situated almost transversely one above the other, between the tuberosity of the ischium and the great trochanter, immediately below the pyriformis, and parted by the tendon of the obturator internus.

The superior and smallest gemellus is fixed to the lower part of the spine of the ischium, to the superior part of the small ischiatic notch, and to a rough line, which runs cross the outside of the ischium, beginning from the spine, and continued under the acetabulum, where it is bent downward.

The inferior and largest gemellus is fixed to the superior and back part of the tuberosity of the ischium, and to a rough impression which runs cross the outside of the ischium from the lower extremity of the ischiatic notch, and is bent upward toward the other line, together with which it forms a sort of irregular semi-circle.

Both these muscles have likewise a small insertion in the inside of the ischium, where, being united together by a particular membrane, one of them joins the upper side, and the other the lower side of the obturator internus, a little after it has passed over the notch: They inclose it as in a bag, and continue to be fixed to it by fleshy fibres all the way to its extremity.

## OBTURATOR EXTERNUS.

THIS is a small flat muscle, which fills up the foramen ovale of the os innominatum exteriorly, and reaches

from thence to the great trochanter of the os femoris, behind the neck of that bone.

It is fixed by fleshy fibres to the outer anterior side of the os pubis, all the way to the foramen ovale, to the edge of that hole, next the small ramus of the ischium, and a little to the neighbouring parts of the obturator ligament.

From thence its fibres, contracting in breadth, pass on the fore side of the great ramus of the ischium, under the acetabulum, where a tendon is formed, which continues its course behind the neck of the os femoris toward the great trochanter, and is inserted between the gemelli and quadratus, in a small fossula between the apex of the great trochanter, and the base of the collum femoris.

### QUADRATUS.

THIS is a small, flat, fleshy muscle, of the figure of an oblong square, from whence it has its name. It is situated transversely between the tuberosity of the ischium and the great trochanter.

It is fixed by one extremity along that obtuse line which runs from under the acetabulum, toward the lower part of the tuberosity of the ischium. From thence it runs directly toward the great trochanter, and is inserted in almost all the lower half of the oblong eminence in that apophysis; but chiefly in the small rising or tuberosity in the middle of that eminence.

### MUSCULUS FASCIAE LATÆ.

THIS is a small and pretty long muscle, situated a little obliquely upward and downward on the forepart of the hip.

It is fixed above to the outside of the anterior superior spine of the os ilium, between the insertions of the gluteus medius and sartorius. From thence its fleshy fibres run down a little obliquely backward, forming a very flat body, four fingers breadth in length, and two in breadth.

This body lies between two laminae of the fascia lata, and is inserted therein by short tendinous fibres, which disappear at that place where the fascia adheres to the great trochanter and tendon of the gluteus maximus.

### Uses of the Muscles which move the Os Femoris on the Pelvis.

THE gluteus maximus serves chiefly, by its posterior portion, to extend the os femoris, and to draw it backward. By its anterior portion, it may co-operate with the rest in performing the abduction of the thigh; but when we sit, it can do this office only by its posterior portion.

By its insertion in the os coccygis, it may on some occasions bring it forward, and hinder it from being thrust too far backward, as in the excretion of hardened faeces, or in difficult births.

The gluteus medius is commonly, but falsely, reckoned an extensor of the thigh. Its use is to separate one

thigh from the other, when we stand, and that more or less directly according to the action of its anterior, posterior, or middle portions.

When we sit, the only use of this muscle is to perform the rotation of the os femoris about its axis, in such a manner, that if the leg be bent at the same time, it shall be separated from the other.

The gluteus minimus has likewise been reckoned an extensor of the thigh, but without any foundation. It assists the gluteus medius in the abduction of the thigh when we stand, and in the rotation when we sit.

The psoas bends the thigh on the pelvis, or brings it forward. It may likewise move the pelvis on the thighs, and hinder it from being carried along with the rest of the trunk, when the body is inclined backward while we sit, having the lower extremities fixed by some external force. In this situation it may likewise move the vertebrae of the loins.

The iliacus is a congener or assistant to the psoas, in bringing the thigh forward and upward. It may likewise move the pelvis in the same manner with the former.

The pectineus is an assistant to the two former muscles in moving both the thigh and the pelvis. It may likewise assist in bringing the thigh inward, or toward the other, whether it be extended or bent at the same time.

The three triceps muscles join in the same use; that is, to move the thigh inward, and bring the two thighs near each other; as when, in riding, we press the thighs close against the saddle; when, in sitting, we hold any thing close between the knees; when we cross the thighs; or when, in standing, we bring the legs close together, in order to jump.

The use of these muscles is likewise to hinder the thighs from separating more than is convenient, especially in great efforts and jerks.

The pyriformis, gemelli, and quadratus, called likewise by the common name of *quadrigeni*, are congeners in their uses; and these have been confined by anatomists to the rotation of the os femoris about its axis from before outward, when we stand or lie at full length; likewise in sitting, or when the thigh is bent in any other posture, they carry the thigh outward, or separate the two thighs from each other when bent.

All the four co-operate in these two uses of rotation and abduction; but they co-operate equally or unequally, according to the different degrees of the extension or flexion of the thigh.

The obturator internus has nearly the same uses with the quadrigeni, in making the rotation of the thigh when extended, and the abduction when bent.

The obturator externus concurs with the internus in the same uses, though in a more simple manner, and in a more uniform direction. It acts chiefly when the thigh is extended more or less.

The musculus fasciæ latæ makes a rotation from before inwards, that is, in a contrary direction to that made by the quadrigeni and obturator internus; and this rotation is not so much confined as that of the quadrigeni, because it may have place whether the thigh be bent or extended.

SECT.

SECT. X. *The MUSCLES which move the Bones of the Leg on the Os Femoris.*

**RECTUS ANTERIOR** *see* GRACILIS ANTERIOR.

THIS muscle is as long as the os femoris; and lies directly along the forefide of the thigh, from whence it has the name of *rectus anterior*.

It terminates above, by a pretty strong tendon, which is divided into two branches, one short and straight, the other long and bent. The short branch, running up in a straight line, is inserted in the anterior inferior spine of the os ilium.

The long branch is inflected backward over the supercilium of the acetabulum, and runs in the direction thereof, from the spine toward the great ischiatic sinus. It is strong and flat, adhering very closely to the bone, and covered by the orbicular ligament and the glutæus minimus.

From thence the muscle runs down wholly fleshy, and partly penniform, some of its fibres meeting above and separating below. It is narrow at the upper extremity, and grows gradually broader toward the middle. Afterwards it contracts again in the same manner, and, at the lower extremity of the os femoris, ends in a flat broad tendon.

**VASTUS EXTERNUS.**

THIS is a very large fleshy muscle, almost as long as the os femoris, broad at the extremities, and thick in the middle, lying on the outside of the thigh.

Its upper insertion, being something tendinous, is in the posterior or convex rough surface of the great trochanter. It is likewise fixed by a fleshy insertion along the outside of the os femoris for above two thirds of its length downward, in the corresponding part of the linea aspera, and in the neighbouring portion of the fascia lata.

From all this extent the fleshy fibres running downward, and a little obliquely forward toward the rectus anterior, terminate insensibly in a kind of short aponeurosis, which is fixed in all the nearest edge of the tendon of the rectus, in the side of the patella, in the edge of the ligament of that bone, and in the neighbouring lateral part of the head of the tibia.

**VASTUS INTERNUS.**

THIS muscle is very like the former, and situated in the same manner on the inside of the os femoris.

It is fixed above by a short flat tendon, in the anterior rough surface of the great trochanter, and by fleshy fibres in that oblique line which terminates the basis of the collum femoris anteriorly, on the forefide of the insertions of the psoas and iliacus, in the whole inside of the os femoris, and in the linea aspera on one side of the insertions of the three tricipites, almost down to the internal condyle.

From all this extent the fibres run downward, and a little obliquely forward, and the body of the muscle in-

creases in the same manner as the vastus internus. It terminates below in an aponeurosis, which is fixed in the edge of the tendon of the rectus anterior, in the side of the patella, and of its tendinous ligament, and in the side of the head or upper extremity of the tibia.

**CRUREUS.**

THIS is a fleshy mass, covering almost all the forefide of the os femoris between the two vasti, which likewise cover the edges of this muscle on each side.

It is fixed to the forefide of the os femoris, from the anterior surface of the great trochanter down to the lowest quarter of the bone, by fleshy fibres which run down successively over each other, between the two vasti, and are partly united to these two muscles, so as not to seem to form a distinct muscle.

It is not so thick as the two vasti; and as it is covered by them on each side, a sort of fleshy channel is formed by all the three, in which the rectus is lodged, covering the forepart of the crureus.

It terminates below in a tendinous aponeurosis, which joins the backside of the tendon of the rectus anterior, and the neighbouring edges of the extremities of the two vasti. Thus, these four muscles form a common tendon, which is inserted in the places already mentioned.

**SARTORIUS.**

THIS is the longest muscle of the human body. It is flat, and about two fingers in breadth, situated obliquely along the inside of the thigh.

It is fixed above by a very short tendon, in the lower part of the anterior superior spine of the os ilium, before the musculus fasciæ latæ. The beginning of its body lies in the notch between the two anterior spines of that bone.

From thence it runs down obliquely over the vastus internus and other muscles that lie near it, all the way to the inside of the knee, where it terminates in a small tendon, which grows broader near its extremity, and is inserted obliquely and a little transversely in the forepart of the inside of the head of the tibia, near the spine or tuberosity of that bone, immediately above the insertion of the gracilis internus.

**GRACILIS INTERIOR** *see* RECTUS INTERIOR.

THIS is a long thin muscle, lying in a straight line on the inside of the thigh, between the os pubis and the knee.

It is fixed in the edge of the inferior branch of the os pubis, near the symphysis, by a broad and very short tendon, on one side of the insertion of the triceps secundus, but a little lower down.

From thence the fleshy fibres contracting a little in breadth, run down to the internal condyle of the os femoris, where they terminate in a thin tendon, which afterwards degenerates into a kind of aponeurosis, and is inserted in the fore-part of the inside of the head of the tibia.

**BICEPS.**

## BICEPS.

THIS muscle is made up of two portions, one long, the other short, and they end in a common tendon. Both portions are fleshy and considerably thick, being situated on the back and outside of the thigh, between the buttock and ham.

The great portion is fixed above, by a strong tendon, in the posterior and lower part of the tuberosity of the ischium, under the insertion of the inferior gemellus, and close behind that of the semi-nervosus. From thence it runs down toward the lower extremity of the thigh, where it meets the other portion, and joins with it in forming a common tendon.

The small portion is fixed, by fleshy fibres, to the outside of the linea aspera, below its middle, and to the fascia lata, where it forms a septum between the triceps and vastus externus. From thence the fibres run down a little way, and then meeting the great portion, a common tendon is formed between them.

This strong tendon runs down to the outer and back-part of the knee, and is inserted in the lateral ligament of the joint, and in the head of the fibula, by two very short tendinous branches.

## SEMI-NERVOSUS.

THIS is a long muscle, half fleshy and half tendinous, or like a nerve, from whence it has its name. It is situated a little obliquely, on the posterior and inner part of the thigh.

It is fixed above to the posterior part of the tuberosity of the ischium, immediately before, and a little more inward than the biceps. It is afterwards fixed, by fleshy fibres, to the tendon of the biceps, for about the breadth of three fingers, much in the same manner as the coracobrachialis is fixed to the biceps of the arm.

From thence it runs down fleshy toward the lower part of the inside of the thigh, having a sort of tendinous interfection in the inner part of its fleshy portion. Having reached below the middle of the thigh, it terminates in a small, long, round tendon, which runs down to the inside of the knee, behind that of the gracilis, where it expands in breadth.

It is inserted in the inside of the upper part of the tibia, about two or three fingers breadth below the tuberosity or spine, immediately under the tendon of the gracilis internus, with which it communicates.

## SEMI-MEMBRANOSUS.

THIS is a long thin muscle, partly tendinous, from whence it has its name, and situated on the back-side of the thigh, a little towards the inside.

It is fixed above, by a broad tendon or long aponeurosis, in the irregular, obtuse, prominent line which goes from the acetabulum to the tuberosity of the ischium, a little above the insertion of the semi-nervosus, and between those of the gemellus inferior and quadratus.

From thence it runs down fleshy in an oblique direction behind the inner condyle of the os femoris, below which

it terminates in a thick tendon, which is inserted in the posterior and interior side of the inner condyle of the tibia, by three short branches, the first or uppermost of which goes a little toward the inside, the second more backward, and the third lower down.

## POPLITEUS.

THIS is a small muscle, obliquely pyramidal, situated under the ham.

It is fixed above, by a strong narrow tendon, to the outer edge of the inner condyle of the os femoris, and to the neighbouring posterior ligament of the joint. From thence it runs obliquely downward under the inner condyle of the os femoris; it is a flat and pretty thick fleshy body, increasing gradually in breadth, till it is fixed in the back-side of the head of the tibia, all the way to the oblique line or impression observable on that side.

*Uses of the Muscles which move the Bones of the Leg or the Os Femoris.*

THE two vasti and crureus ought to be looked upon as a true triceps, the uses of which, in relation to the bones, are only to extend the tibia on the os femoris, and the os femoris on the tibia. The extension of the tibia on the os femoris happens chiefly when we sit or lie, and that of the os femoris on the tibia when we stand or walk. All the three muscles move the patella uniformly in the direction of the os femoris, on the pulley at the lower extremity of that bone.

The insertion of both the vasti immediately in the head of the tibia, prevents the patella from being luxated laterally on some occasions, in which the muscles may act with more force on one side than on the other, or remain without action, in which case the patella is loose and floating.

The rectus anterior, by its insertion in the patella, is a congener to the last three muscles, and serves to extend the leg. By its insertion in the os ilium, it bends the thigh, and assists the psoas, iliacus, and pectineus, whether the leg be extended or bent. It likewise moves the pelvis forward on the os femoris, and hinders it from falling back when we sit.

The sartorius performs the rotation of the thigh from before outward, whether extended or bent; being an antagonist to the musculus fasciæ latæ, and a congener to the quadrigemini.

It likewise bends the thigh, or raises it forward; it moves the pelvis forward on the femoris; and when the pelvis rests on the two tuberosities of the ischium in sitting, it keeps it in that situation.

Lastly, it bends the leg, whether it performs the rotation of the thigh at the same time or not.

The gracilis internus bends the leg much in the same manner with the sartorius, which it assists in this function, but not in that of turning the leg.

It may likewise assist the triceps in the adduction of the thigh, which it performs with much more facility than it begins the flexion of the leg without the rotation of the thigh.

The

The *semi-nervosus* bends the leg, and may likewise bend the thigh on the leg. By its insertion in the tuberosity of the ischium, it likewise extends the thigh on the pelvis, and carries it backward; and may also extend the pelvis on the thigh, when it has been inclined forward with the rest of the trunk; and consequently prevent its being carried too far along with the trunk, when we stoop forward, either standing or sitting.

The *semi-membranosus* has the same uses with the *semi-nervosus*. It bends the leg on the thigh, and the thigh on the leg; it extends the thigh on the pelvis, and the pelvis on the thigh, and sustains the pelvis when it is inclined forward.

The two portions of the *biceps* bend the leg on the thigh, and the thigh on the leg. The superior portion likewise extends the thigh on the pelvis, and the pelvis on the thigh. These four uses in general are common to this muscle with the *semi-membranosus*, and in some measure with the *semi-tendinosus*.

The particular use of the *biceps*, and which seems to belong more to the short portion than to the other, is to perform the rotation of the leg when bent, by which motion the toes are turned outward, and the heel inward.

The *popliteus* performs the rotation of the leg when bent, in a direction contrary to that of the *biceps*. The *biceps* turns the leg from before outward; the *popliteus* from before inward.

## SECT. XI. The Muscles which move the Tarsus on the Leg.

### TIBIALIS ANTERICUS.

THIS is a long muscle, fleshy at the upper part, and tendinous at the lower, situated on the fore-side of the leg, between the tibia and the *extensor digitorum longus*.

It is fixed above, by fleshy fibres, in the upper third part of the external labium of the crista tibiae, and of the inside of the *aponeurosis tibialis*, or of that ligamentary expansion which goes between the crista tibiae and the anterior angle of the fibula. It is likewise fixed obliquely in the upper two thirds of the outside of the tibia, or that next the fibula.

From thence it runs down and ends in a tendon, which first passes through a ring of the common annular ligament, and then through another separate ring situated lower down. Afterwards the tendon is fixed, partly in the upper and inner part of the *os cuboides*, and partly in the inside of the first bone of the *metatarsus*.

### PERONÆUS MEDIUS vulgo PERONÆUS ANTERICUS.

THIS is a long muscle, situated anteriorly on the middle part of the fibula.

It is fixed above, by fleshy fibres, to more than the middle third part of the anterior or outside of the fibula, and to the neighbouring part of the *aponeurosis tibialis*.

It is likewise fixed to a production from the inside of that *aponeurosis* which runs to the upper part of the ti-

bia, and there serves for a middle septum between this muscle and the *extensor digitorum longus*.

From thence it runs down and forms a tendon, which going in the direction of the oblique line on the fibula, passes behind the external malleolus, and then through an annular ligament common to it and to the *peronæus maximus*, and is afterwards inserted in the tuberosity at the basis of the fifth metatarsal bone, sending off a small tendon to the first phalanx of the little toe.

### PERONÆUS MINIMUS.

THIS is a small muscle, commonly thought to be a portion of the *extensor digitorum longus*, though it is easily separable from it.

It is fixed, by fleshy fibres, in the lower half of the inside of the fibula, between two oblique bony lines, on one side of the lower part of the *extensor digitorum longus*, to which muscle it is simply contiguous.

From thence it runs down contracting in breadth, and passes with the *extensor longus*, through the common annular ligament, forming a flat tendon, which soon separates from those of the *extensor*, and is inserted near the basis of the fifth metatarsal bone.

### GASTROCNEMII.

THESE are two thick, pretty broad, and oblong muscles, situated laterally with respect to each other, in the same plane, under the poples, and forming a great part of what is called the calf of the leg. That which lies next the tibia is called *internus*, and that next the fibula, *externus*; and because they form, as it were, the belly of the leg, they have been termed in Greek *gastrocnemii*.

Each muscle is fixed above, by a flat tendon, to the posterior part of the lower extremity of the *os femoris*, behind the lateral tuberosity of each condyle, adhering closely to the posterior ligaments of the joint of the knee.

From thence they run down, each forming a large and pretty broad fleshy body, irregularly oval.

About the middle of the leg, they end in a strong, broad, common tendon, which contracts a little in breadth as it descends, and is inserted in the posterior extremity of the *os calcis*, together with the tendon of the *soleus*.

### SOLEUS.

THIS is a large, fleshy, flat muscle, nearly of an oval figure, and thicker in the middle than at the edges. It is situated on the back-side of the leg, lower down than the *gastrocnemii*, by which it is covered; and these three muscles form the calf of the leg.

It is fixed above, partly to the tibia, and partly to the fibula.

Afterwards leaving these two bones, it ends in a broad strong tendon, which, together with that of the *gastrocnemii*, forms what is called *tendo Achillis*. This strong tendon contracts a little in its passage to the *os calcis*, and then expanding a little, it is inserted obliquely in the back-side of that bone, all the way to the tuberosity.

**TIBIALIS GRACILIS** *vulgo* **PLANTARIS.**

THIS is a small pyriform muscle, situated obliquely in the ham below the external condyle of the os femoris, between the popliteus and gastrocnemius externus; and its tendon, which is long, flat, and very small, runs down on the side of the gastrocnemius internus, all the way to the heel.

The fleshy body, which is only about two inches in length, and one in breadth, is fixed, by a short flat tendon, above the outer edge of the exterior condyle of the os femoris, on one side of the gastrocnemius externus. From thence the fleshy body runs obliquely over the edge of the popliteus, and terminates in a very small, long, flat tendon.

This tendon runs between the body of the gastrocnemius externus and soleus, all the way to the inner edge of the upper part of the tendo Achillis; and from thence continuing its course downward, it joins this tendon, and is inserted, together with it, in the outside of the posterior part of the os calcis, without communicating with the aponeurosis plantaris.

**TIBIALIS POSTICUS.**

THIS is a long, fleshy, penniform muscle, broader above than below, situated between the tibia and fibula, on the back-side of the leg, and covered by the extensor digitorum longus.

It is fixed above, by fleshy fibres, immediately under the articulation of the tibia and fibula, to the nearest parts of these two bones, chiefly to the tibia, reaching to the lateral parts of that bone, above the interosseous ligament, which is here wanting.

From thence its insertion is extended below the oblique line or impression in the tibia, over all the neighbouring part of the interosseous ligament, and through more than the upper half of the internal angle of the fibula.

After this, it forms a tendon, which runs down behind the inner malleolus, through a cartilaginous groove and an annular ligament, and, passing under the malleolus, is inserted in the tuberosity or lower part of the os scaphoides.

**PERONEUS MAXIMUS** *vulgo* **PERONEUS POSTERIOR.**

THIS is a long penniform muscle, lying on the fibula.

It is fixed above to the anterior and outer part of the head of the fibula, and to a small portion of the head of the tibia; then to the outside of the neck of the fibula, to the upper half of the external angle of that bone, and to the aponeurosis tibialis, which at that place makes a septum between this muscle and the extensor pollicis.

From thence turning a little backward, according to the direction of the bone, it forms a considerable tendon, which, running behind the external malleolus, passes through a kind of hollow groove, and through an annular ligament common to it and to the tendon of the peroneus medius, which lies before it.

Afterwards running through the oblique groove in the lower side of the os cuboides, it is inserted in the side of

the basis of the first metatarsal bone, and also a little in the basis of the os cuneiforme majus.

**SECT. XII. The MUSCLES which move the Metatarsus and Toes.****EXTENSOR POLLICIS LONGUS.**

THIS is a thin single muscle, lying between the tibialis anticus and extensor digitorum longus, by which it is almost hid.

It is fixed to the inside of the fibula, near the interosseous ligament, from the neck down to the lowest quarter of that bone; to the interosseous ligament through the same space, and a little to the lower extremity of the tibia next the fibula.

There it ends in a considerable tendon, which passing through a distinct ring of the common annular ligament, and then through a membranous vagina, is inserted in the basis of the first phalanx of the great toe, and continued from thence up to the second.

**FLEXOR POLLICIS LONGUS.**

THIS is a pretty long muscle, situated in the posterior and lower part of the leg.

It is fixed in the lower half of the back-side of the fibula, its insertion reaching almost as far as the external malleolus. The fleshy body advances on the inside of that bone towards the tibia, according to the oblique direction of that side, and ends in a large tendon.

This tendon passes behind the lower extremity of the tibia, toward the inner ankle, then through a small notch in the inner and back-side of the astragalus, and through an annular ligament or ligamentary vagina, continued under the lateral arch of the os calcis.

From thence it advances to the great toe, and passing through the interstice between the two sesamoid bones, in the ligamentary vagina of the first phalanx, is inserted in the lower part of the second.

**T H E N A R.**

THIS muscle is made up of several portions, and lies on the inner edge of the sole of the foot.

It is fixed, by three or four fleshy fasciculi, to the lower and inner part of the os calcis, os scaphoides, and os cuneiforme majus. It is likewise fixed a little in the annular ligament under the inner ankle, which belongs to the tendon of the flexor longus.

From all these different insertions, the fleshy fasciculi approach each other as they advance forward under the first bone of the metatarsus, and are fixed, partly in the internal sesamoid bone, and partly in the inside of the first phalanx, near its basis.

**A N T I T H E N A R.**

THIS is a small compound muscle, lying obliquely under the metatarsal bones.

It

It is fixed posteriorly in the lower parts of the second, third, and fourth metatarsal bones, near their basis; in the ligament belonging to the first and second of these bones; in the neighbouring ligaments belonging to the bones of the tarsus; and, lastly, in a lateral aponeurosis of the muscle commonly called *hypothenar*:

All these portions, contracting into a small compass, are inserted in the outside of the external sesamoid bone, and of the first phalanx of the great toe.

### EXTENSOR DIGITORUM LONGUS.

This is a long muscle, fleshy in the upper part, and tendinous in the lower, lying between the tibialis anticus and peronæus maximus.

It is fixed above, by fleshy fibres, in the outside of the head of the tibia, and inside of the head of the fibula; in the upper part of the interosseous ligament, through three fourths of the length of the fibula; and through the same space, in the tendinous septum belonging to the anterior angle of that bone.

It contracts in breadth a little above the annular ligament, and, in passing through it, is divided into three tendons; the first of which is afterwards divided into two. These four tendons are inserted along the upper or convex side of the four small toes.

### EXTENSOR DIGITORUM BREVIS.

This is a small complex muscle, lying obliquely on the convex side of the foot, being likewise termed *pediculus*.

It is fixed in the upper and outer side of the anterior apophysis of the astragalus, and in the neighbouring part of the upper side of that bone. From thence it runs obliquely from without inwards, under the tendons of the peronæus minimus and extensor digitorum longus, being divided into four fleshy portions, which terminate in the same number of tendons.

The first tendon is inserted in the upper or convex part of the first phalanx of the great toe. The other three joining with those of the extensor longus, are inserted along the convex sides of all the phalanges of the three following toes.

### FLEXOR DIGITORUM BREVIS *sive* PERFORATUS PEDIS.

This is the undermost of all the common muscles of the toes, being situated immediately above the aponeurosis plantaris.

It is fixed by fleshy fibres to the anterior and lower part of the great tuberosity of the os calcis; and to the neighbouring part of the upper side of the aponeurosis plantaris.

From thence it runs forward, being divided into four fleshy portions, which terminate in the same number of tendons, split at their extremities, in the same manner as those of the sublimis or perforatus of the hand, and inserted in the second phalanges of the four small toes.

### FLEXOR DIGITORUM LONGUS *sive* PERFORANS PEDIS.

This is a long muscle, fleshy above, and tendinous below, lying on the backside of the leg between the tibia and the flexor pollicis longus, covered by the soleus, and covering the tibialis posticus.

It is fixed above, by fleshy fibres, to a little more than the middle third part of the backside of the tibia near its external angle, below the insertion of the soleus; and also to a kind of ligament which runs down from the middle of the tibia. It afterwards ends in a tendon which passes behind the inner ankle, on one side, and a little behind the tibialis posticus, in a separate annular ligament.

From thence it runs under the sole of the foot, sending off a detachment, by which it communicates with the flexor pollicis longus. There it is divided into four small flat tendons, which go to the third phalanges of the four small toes in the same manner, as the perforans of the hand.

### FLEXOR DIGITORUM ACCESSORIUS.

This is a flat and pretty long fleshy mass, situated obliquely under the sole of the foot.

This muscle is fixed posteriorly by one fleshy portion, in the lower side of the os calcis, and in the anterior tuberosity on that side, and by the other in the neighbouring ligament which joins this bone to the astragalus.

From thence the two portions run obliquely to the middle of the sole of the foot, and there unite in a flat, long, and irregularly square muscular mass, which is fixed to the outer edge of the fasciculus of tendons of the flexor longus, to which it serves as a strænum at that place.

### LUMBRICALES.

THESE are four small muscles, situated more or less longitudinally under the sole of the foot.

They are fixed by their fleshy extremities to the four tendons of the flexor digitorum longus near the insertion of the flexor accessorius. The first muscle is fixed to the inside of the first tendon; the second to the tendinous fork formed by the two first tendons; the third, to the tendinous fork made by the second and third tendons; and the fourth, in the same manner to the third and fourth tendons, but commonly most to the third.

From thence these four muscles run to the toes, and there terminate in the same number of small tendons, which are inserted in the first phalanges of the toes, much after the same manner as in the hand.

### TRANSVERSALIS DIGITORUM.

This is a small muscle, which lies transversely under the basis of the first phalanges, and which at first sight appears to be a simple muscular body fixed by one end to the great toe, and by the other to the little toe.

When

When this muscle is carefully examined, we find that it is fixed, by a very short common tendon, to the outside of the basis of the first phalanx of the great toe, conjointly with the antithenar; and, by three different portions or digitations, to the three interosseous ligaments which connect the heads of the four metatarsal bones next the great toe, laterally to each other.

### INTEROSSEI.

THESE are seven small muscles which fill up the four interstices between the metatarsal bones, much after the same manner as in the hand. The four largest are superior, the other three inferior.

### METATARSII.

THIS is a fleshy mass, lying under the sole of the foot. It is fixed, by one end, in the fore-part of the great tuberosity of the os calcis; and running forward from thence, it terminates in a kind of short tendon, which is fixed in the tuberosity and posterior part of the lower side of the fifth bone of the metatarsus.

### PARATHENAR MAJOR.

THIS is a pretty long muscle, forming part of the outer edge of the sole of the foot.

It is fixed backwards by a fleshy body, to the outer part of the lower side of the os calcis, from the small posterior external tuberosity, all the way to the anterior tuberosity. There it joins the metatarsus, and at the basis of the fifth metatarsal bone separates from it again, and forms a tendon, which is inserted in the outside of the first phalanx of the little toe, near its basis, and near the insertion of the parathenar minor.

### PARATHENAR MINOR.

THIS is a fleshy muscle, fixed along the posterior half of the outer and lower side of the fifth bone of the metatarsus. It terminates under the head of that bone, in a tendon which is inserted in the lower part of the basis of the first phalanx of the little toe.

### USES of the Muscles which move the Tarsus and the other Bones of the Foot.

THE tibialis anticus bends the foot, that is, turns the point of the foot toward the leg; which motion is performed by the ginglymoid articulation of the astragalus with the tibia and ulna. It likewise bends the leg on the foot, or hinders its extension.

By its lateral insertion in the os cuneiforme maximum, it moves this bone in particular over the anterior extremity of the os calcis; by which the sole of the foot is turned inward toward the other.

The peronæus medius bends the foot, and hinders the leg from falling back in the same manner as the tibialis anticus. By its insertion in the tuberosity of the fifth metatarsal bone, it turns the sole of the foot outward at

the same time that it bends it, when it acts without the assistance of the tibialis anticus.

The peronæus minimus is an assistant to the medius in the flexion of the foot, in preserving the æquilibrium of the leg, and in turning the sole of the foot outward.

THE gastrocnemii and soleus make a kind of triceps; and, by their common tendon, extend the foot, and keep it extended against the strongest resistance. It is by their means that we raise the whole body, even with an additional burden, when we stand a tip-toes; and that we walk, run and jump.

The gastrocnemii, by their insertion in the os femoris, may, in great efforts, move the leg on the thigh, and the thigh on the leg, as assistants to the biceps, semi-membranosus, semi-tendinosus, gracilis internus, and sartorius.

The soleus, by the multitude of its fleshy fibres and its penniform structure, is more proper for strong than large motions, and seems principally to sustain the gastrocnemii in the motions begun by them. The tendinous portions of this muscle and of the gastrocnemii, tho' they form a strong tendon all together, seem nevertheless to slide a little upon each other in the different flexions and extensions of the foot.

Anatomists are not agreed with regard to the use of the tibialis gracilis.

When the tibialis posticus acts alone, it extends the foot obliquely inward. When it acts together with the gastrocnemii and soleus, it changes the straight direction of their motion to an oblique one. When it acts with the tibialis anticus, the sole of the foot is turned more directly inward, or toward the other foot.

When the peronæus longus or maximus acts alone, it may extend the foot hanging freely in the air; but then this extension is obliquely outward. Together with the gastrocnemii and soleus, it likewise changes their direction to an oblique extension outward.

The extensor pollicis longus extends the two phalanges of the great toe; and it may likewise be an assistant to the tibialis anticus.

The flexor pollicis longus not only bends the second phalanx of the great toe, but may likewise serve, in great efforts, as an assistant to the extensors of the tarsus. This muscle is of great use in climbing up a steep place.

The thenar bends the first phalanx of the great toe. When the portion nearest the inner edge of the foot either acts alone, or acts more than the rest, the great toe is separated from the other toes, especially if it be at the same time extended.

The antithenar, acting with the thenar, bends the first phalanx of the great toe. When it acts alone, especially if the great toe is bent, it brings it nearer the other toes, in proportion to the degrees of action of its different portions.

The two extensores digitorum communes concur in extending the four small toes; and, as the extensor longus is not near so fleshy as that of the hand, this difference is made up by the extensor brevis. The longus alone seems to extend the first phalanges; and they both join in the extension of the second and third phalanges; the brevis, by the obliquity of its direction, moderating the action



tion of the longus; which otherwise would have turned the toes obliquely the contrary way.

The perforatus or flexor digitorum brevis, beards the second phalanges; and the perforans or flexor longus, the third; the use of these muscles being nearly the same with those of the perforatus and perforans of the hand.

The flexor accessorius is an assistant to the perforans, increasing its force on some occasions. It likewise directs the tendon of that muscle; for by contracting, at the same time that the fleshy belly of the perforans is in action, it makes the tendons go in a straighter line to the toes than they would otherwise do, because of their obliquity.

The lumbricales have nearly the same functions in the foot as in the hand; and they are partly assisted, and partly directed, by the flexor accessorius.

The interossei of the foot have the same uses as in the hand. The first superior muscle brings the second toe near the great toe; the other three bring the second, third, and fourth toes near the little toe. The three inferior muscles move the last three toes toward the other two.

The metatarsus moves the last bone of the metatarsus, much in the same manner as the metacarpus does that of the metacarpus.

The transversalis may assist the metatarsus in this action, which is supposed to be of use to tilers in climbing. The antithenar may likewise concur, and the peroneus minimus may serve to counterbalance these muscles, and to bring the metatarsus back to its natural situation.

The parathenar major serves particularly to separate the little toe from the rest; and the parathenar minor bends the first phalanx of that toe.

### SECT. XIII. *The MUSCLES employed in Respiration.*

#### DIAPHRAGMA.

THIS is a very broad and thin muscle, situated at the basis of the thorax, and serving as a transverse partition to separate that cavity from the abdomen. For this reason the Greeks termed it *diaphragma*; and the Latins, *septum transversum*. It forms an oblique inclined arch, the fore-part of which is highest, and the posterior part lowest, making a very acute angle with the back.

It is looked upon as a double and digastric muscle, made up of two different portions, one large and superior, called the great muscle of the diaphragm; the other small and inferior, appearing like an appendix to the other, called the small or inferior muscle of the diaphragm.

The great or principal muscle is fleshy in its circumference, and tendinous and aponeurotic in the middle, which, for that reason, is commonly called *construm verum sive tendinosum*.

The fleshy circumference is radiated, the fibres of which it is made up being fixed by one extremity to the

edge of the middle aponeurosis, and by the other to all the basis of the cavity of the thorax, being inserted by digitations in the lower parts of the appendix of the sternum, of the lowest true ribs, of all the false ribs, and in the neighbouring vertebræ.

We have therefore three kinds of insertions; one sternal; twelve costal, six on each side; and two vertebral, one on each side. These last are very small, and sometimes scarcely perceivable. The costal insertions join those of the transversalis abdominis, but do not mix with them, as they seem to do before the membrane which covers them is removed.

The fibres inserted in the appendix ensiformis, run from behind directly forward, and form a small parallel plane.

The first costal insertion runs a little obliquely towards the cartilage of the seventh true rib, a triangular space being left between this and the sternal insertion, at which the pleura and peritonæum meet. The insertion of these fibres is very broad, taking up about two thirds of the cartilage of the seventh rib, and a small part of the bone, from whence it reaches beyond the angle of the cartilage.

The second insertion is into the whole cartilage of the first false rib; the third partly in the bone, and partly in the cartilage of the second false rib; the fourth in the bone, and sometimes a little in the cartilage of the third false rib; the fifth in the bone, and a little in the cartilage of the fourth false rib, being broader than the rest.

The sixth is in the cartilage of the last false rib, and almost through the whole length of the bone. At the head of this rib, it joins the vertebral insertion, which runs from the lateral part of the last vertebra of the back, to the first vertebra of the loins.

The small muscle of the diaphragm is thicker than the other, but of much less extent. It is situated along the fore-side of the bodies of the last vertebra of the back and several of those of the loins, being turned a little to the left hand. It is of an oblong form, representing in some measure a fleshy collar; the two lateral portions of which cross each other, and afterward become tendinous toward the lower part.

The upper part of the body of this muscle is fixed in the slope of the middle aponeurosis of the great muscle. The outer edges of the alæ or lateral portions join the posterior plane of the great muscle, and these portions adhere to the body of the last vertebra of the back. The extremities, called likewise *pillars* or *crura*, are inserted by several tendinous digitations in the vertebræ of the loins.

The upper part of the fleshy body is formed by a particular intertexture of fibres belonging to the two alæ. These two alæ, whereof that toward the right-hand is generally the most considerable, part from each other, and form an oval hole, terminated on the lower part by fibres, detached from the inside of each ala, immediately above the last vertebra of the back. These fibres decussate and cross each other, and afterwards those that come from each ala join that on the other side, so that each of the crura is a production of both alæ.

The fibres that come from the left ala, cross over those from the right ala, and this again sends a small fasciculus of fibres over those of the left ala; afterwards the two crura part from each other.

The right crus is larger and longer than the left, and is always inserted in the four upper vertebræ of the loins, and often in the fifth likewise, by the same number of digitations, which become more and more tendinous as they descend, and at length are expanded in form of an aponeurosis. This crus lies more on the middle of the bodies of the vertebræ than on the right side.

The left crus is smaller and shorter, and lies more on the sides of the vertebræ. It is fixed by digitations to the three upper vertebræ of the loins, seldom reaching lower. The lower part of it is expanded in the same manner as the other; and the two expansions sometimes meet together.

The oval opening of this inferior muscle of the diaphragm, gives passage to the extremity of the œsophagus, and the aorta lies in the interstice between the two crura. Immediately above the opening or hole, a thin fasciculus of fibres is sent off to the stomach.

In the middle aponeurosis of the great muscles, a little to the right of the anterior part of the slope, near the small muscle, is a round opening, which transmits the trunk of the lower vena cava. The border or circumference of this opening is very artfully formed by an oblique and successive intertexture of tendinous fibres, almost like the edge of a wicker basket; and is, consequently, incapable either of dilatation or contraction, by the action of the diaphragm.

We find therefore three considerable openings in the diaphragm; one round and tendinous, for the passage of the vena cava; one oval and fleshy, for the extremity of the œsophagus; and one forked, partly fleshy, and partly tendinous, for the aorta. The round opening is to the right-hand, close to the upper part of the right ala of the small muscle; the oval opening is a little to the left; so that the right ala, which is between these two holes, lies almost directly over against the middle of the body of the eleventh vertebra of the back; the tendinous fork is under the oval opening, but a little more toward the middle.

### SCALENI.

THESE are compound muscles, irregularly triangular.

The scalenus primus is fixed to the upper part of the outside of the first rib, by two distinct portions, called commonly *branches*; one anterior, the other posterior. The anterior branch is fixed to the middle portion of the rib, about an inch from the cartilage. From thence it runs obliquely upward, and is inserted in the transverse apophysis of the sixth, fifth, and sometimes of the third vertebra of the neck.

The posterior branch is fixed more backward in the first rib, an interstice of about an inch being left between it and the other branch, through which the axillary artery and brachial nerves are transmitted. From thence it runs up obliquely behind the former, and is inserted in all the transverse apophyses of the neck.

The scalenus secundus is fixed a little more backward in the external labium of the upper edge of the second rib, sometimes by two separate portions, and sometimes without any division. The anterior portion is fixed immediately under the posterior portion of the first scalenus, by a short flat tendon, united a little with the first intercostal muscle. From thence it runs up over the posterior portion of the first scalenus, communicating likewise with that muscle, and is fixed by insertions, partly tendinous and partly fleshy, in the transverse apophyses of the four first vertebræ of the neck.

The posterior portion is fixed in the second rib, more backward than the other. From thence it runs up, being divided into two portions, whereof one is inserted in the transverse apophyses of the three first vertebræ of the neck, behind the scalenus primus. The other portion runs up behind the former, and is inserted in the transverse apophyses of the two first vertebræ.

### SERRATUS POSTICUS SUPERIOR.

THIS is a flat thin muscle, situated on the upper part of the back. It is fixed on one side, by a broad aponeurosis, to the lower part of the posterior cervical ligament, and to the spinal apophyses of the two last vertebræ of the neck, and two first of the back.

From thence it runs down a little obliquely forward, and is inserted, by broad fleshy digitations, in the posterior part of the second, third, fourth, and sometimes of the fifth true ribs, near their angles; but sometimes it has no insertion in the second rib.

### SERRATUS POSTICUS INFERIOR.

THIS is a flat thin muscle, lying on the lower part of the back. It is fixed in the last spinal apophysis of the back, and in the three first of the loins, by a broad aponeurosis. From thence it runs up a little obliquely, and is fixed, by fleshy broad digitations, in the last four false ribs. Its insertions, in the lowest rib, is near the cartilage, and, in the other three, near their angles.

### INTERCOSTALES.

THE intercostal muscles are thin, fleshy planes, lying in the interstices between the ribs, their fibres running obliquely from one rib to another. In each interstice lie two planes, an external and an internal, closely joined together, nothing but a thin, fine, cellular, membranous web coming between them.

According to this natural division, there must be forty-four intercostal muscles in the twenty-two interstices left between the twenty-four ribs; and of these there are eleven external, and eleven internal, on each side. The fibres of the external intercostals run down from behind forward, and those of the internal intercostals from before backward; so that the fibres of these two series of muscles cross each other.

The external intercostals extend commonly from the vertebræ to the extremity of the upper labium of the bony portion of each rib, and go no further. The internal

ternal begin forward near the sternum, and end backward at the angle of each rib.

### SUPRA-COSTALES.

THESE muscles are irregularly triangular, and situated on the back-part of the ribs, near the vertebræ.

Each of these muscles is fixed, by one tendinous extremity, in the transverse apophysis, which lies above the articulation of each rib, and to the neighbouring ligament; the first being inserted in the transverse apophysis of the last vertebra of the neck; and the last, in that of the eleventh vertebra of the back.

From thence the fleshy fibres run down obliquely, increasing in breadth as they descend, and are inserted in the back part of the outside of the following rib.

### SUB-COSTALES.

THESE are fleshy planes, of different breadths, and very thin, situated more or less obliquely on the insides of the ribs, near the bony angles, and running in the same direction with the external intercostals.

They are fixed by both extremities in the ribs; the inferior extremity being always at a greater distance from the vertebræ than the superior, and several ribs lying between the two insertions.

### STERNO-COSTALES *vulgo* TRIANGULARIS STERNI.

THESE are five pairs of fleshy planes, disposed more or less obliquely on each side the sternum, and on the inside of the cartilages of the second, third, fourth, fifth, and sixth true ribs.

They are inserted, by one extremity, in the edges of the inside of all the lower half of the sternum. From thence the first muscle on each side runs up obliquely, and is fixed in the cartilage of the second rib. The second runs less obliquely to its insertion in the cartilage of the third rib. The rest are inserted, in the same manner, in the cartilages of the following ribs.

This last muscle is fixed, by one extremity, in the cartilage of the sixth true rib, near the bone, and seems to pass the appendix *ensiformis*, immediately above the insertion of the diaphragm in that appendix, and so join the muscle on the other side.

#### Uses of the Muscles employed in Respiration.

THE scaleni are sometimes ranked among those which serve for respiration; but they ought rather to be ranked among the muscles which move the vertebræ of the neck; because the articulation of the first rib on both sides, with the first vertebra of the back, seems to serve only for the motion of that vertebra on the rib, and not of the rib on the vertebra.

The serratus *posticus superior* is disposed to move upwards the three or four upper ribs next the first.

The serratus *posticus inferior* is still better disposed for depressing and keeping down the last three or four false ribs.

The posterior fibres of the external intercostals are

fixed, by their upper extremities, so near the articulation of the ribs with the vertebræ, that they cannot depress that rib in which they are so inserted; whereas the insertions of their lower extremities in the following rib being at a greater distance from the articulation, they may move that rib upward. And from thence it follows, that all the remaining part of each external intercostal which terminates at the bony extremity of each rib, can only serve to raise the lower rib toward the upper.

The anterior fibres of the internal intercostals are so near the articulation of the ribs with the sternum, that they cannot depress that cartilage in which each of them is inserted; whereas the inferior insertions of these fibres being at a greater distance from the articulation, they are in a condition to raise the cartilages in which they are so inserted. From whence it follows, that all the internal intercostal muscles have the same use with the external, and that they can have no other.

The supra-costales are powerful assistants to the intercostals in their common action, and are therefore very justly termed *levatoros costarum*.

The sterno-costales depress the cartilaginous portions, and anterior extremities of the ribs, especially the superior ribs, except the first; and at the same time draw the cartilages of the inferior ribs near the sternum, by reason of the curvature. They may therefore very well be called *depressores costarum*, as the supra-costales are named *levatoros*.

The sub-costales having the superior extremities of their fibres much more distant from the vertebral articulation of the ribs than the lower extremities, it follows, that they can more easily move the upper than the lower ribs, and consequently that they are assistants to the sterno-costales.

The diaphragm, together with the intercostal muscles, the ribs, sternum, and vertebræ of the back, forms the cavity of the thorax, and it divides this cavity from that of the abdomen.

Its particular use is to be the principal organ of respiration, that is, of the alternate expansion and contraction of the thorax. The other muscles already mentioned are to be considered only as assistants and directors, in order to facilitate and regulate these motions, which, in the ordinary state, are perpetual, but which may, by the action of these other muscles, be accelerated, retarded, or even be suspended for some space of time.

The diaphragm may move when the ribs are at rest, and consequently without the assistance of the muscles which move the ribs; and this motion may be sufficient to keep up the alternate dilatation and contraction of the thorax.

### SECT. XIV. The MUSCLES which move the Head on the Trunk.

#### STERNO-MASTOIDÆUS *sive* MASTOIDÆUS ANTERIOR.

THIS is a long, narrow, pretty thick, and mostly fleshy muscle, situated obliquely between the back-part of

of the ear, and lower part of the throat. It is in a manner composed of two muscles, united at the upper part through their whole breadth, and separated at the lower.

It has two insertions below, both of them flat, and a little tendinous. The first is in the upper edge of the sternum, near the articulation of the clavícula; the other in the clavícula, at a small distance from the sternum.

The sternal portion passes foremost, and covers the clavicular, both forming one body or belly, which running in the same oblique direction to the apophysis mastoïdæus, is inserted in the upper and back-part of that process; over which it likewise sends off a very broad aponeurosis, which covers the splenius, and is inserted in the os occipitis.

#### SPLЕНИUS *sive* MASTOÏDÆUS POSTERIOR.

THIS is a flat, broad, oblong muscle, situated obliquely, between the back-part of the ear, and the posterior and lower part of the neck. It is partly single, and partly made up of two portions, one superior, the other inferior.

The superior portion is fixed to the extremities of the three or four lowest spinal apophyses of the neck, and of the first, or first and second, of the back.

It is likewise fixed to the edge of the inter-spinal ligaments of the other vertebræ.

From thence it runs up obliquely toward the mastoid apophysis, partly under the upper extremity of the sterno-mastoïdæus, and is inserted in the upper part of that process, and along the neighbouring curve portion of the transverse ridge of the os occipitis.

The inferior portion of the splenius is fixed to three or four spinal apophyses of the back, beginning by the second or third. From thence it runs up, being closely united to the other portion, till it reaches the superior and lateral part of the neck, where it separates from it, and is inserted in the transverse apophyses of the three or four superior vertebræ of the neck, by the same number of extremities, a little tendinous, which, however, are sometimes only two in number.

#### COMPLEXUS.

THIS is a pretty long and broad muscle, lying on the posterior lateral part of the neck, all the way to the occiput. It is complicated, by reason of the decussations of its different portions; from which it has its name.

It is fixed below, by small short tendons, to the transverse apophyses of all the vertebræ of the neck, except the first, to which it is fixed only near the root of its transverse apophysis. From thence it runs up obliquely backward, crossing under the splenius, and often communicating with it, by some fasciculi of fibres.

It is afterwards inserted above, by a broad fleshy plane, in the posterior part of the superior transverse line of the os occipitis, near the crista or spine of that bone.

#### COMPLEXUS MINOR *sive* MASTOÏDÆUS LATERALIS.

THIS is a long, slender, narrow indented muscle, ly-

ing along all the side of the neck, up to the ear, where it increases a little in breadth.

It is fixed, by one extremity, in all the transverse apophyses of the neck, except the first, by the same number of digitations or branches, mostly fleshy, and disposed obliquely.

From thence it ascends, and having reached above the transverse apophysis of the first vertebra, it forms a small broad plane, by which it is inserted in the posterior part of the apophysis mastoïdæus.

#### RECTUS MAJOR.

THIS is a small, flat, short muscle, broad at the upper part, and narrow at the lower, situated obliquely between the occiput and second vertebra of the neck.

It is fixed below to one branch of the bifurcated spine of the second vertebra of the neck, at a tuberosity which is often found at the upper part of that branch. From thence it ascends a little obliquely outward, and is inserted in the posterior part of the inferior transverse line of the os occipitis, at a small distance from the crista, being a little covered by the obliquus superior.

#### RECTUS MINOR.

THIS muscle is like the former, and it has also a small insertion below, in the posterior eminence of the first vertebra. From thence it ascends laterally, and is inserted immediately under the posterior part of the inferior transverse line of the os occipitis, in a superficial fossula on one side of the crista occipitalis.

#### OBLIQUUS SUPERIOR *sive* MINOR.

THIS muscle is situated laterally between the occiput and first vertebra, being nearly of the same figure with the two recti. It is fixed to the end of the transverse apophysis of the first vertebra; from whence it runs upward and very obliquely backward, and is inserted in the transverse line of the os occipitis, almost at an equal distance from the crista and mastoid apophyses, between the rectus major and complexus minor.

#### OBLIQUUS INFERIOR *sive* MAJOR.

It is situated in a contrary direction to the obliquus superior, between the first and second vertebra of the neck, resembling that muscle in every thing but the size. It is fixed below to one ramus of the bifurcated spinal apophysis of the second vertebra, near the insertion of the rectus major; from whence it runs obliquely upwards and outward, and is inserted in the end of the transverse apophysis of the first vertebra, under the lower insertion of the obliquus superior.

#### RECTUS ANTICUS LONGUS.

THIS muscle is, in some measure, of a pyramidal figure, lying along the anterior and lateral parts of the vertebra of the neck, all the way up the basis cranii.

It

It is fixed to the anterior parts of the transverse apophysis of the third, fourth, fifth, and sixth vertebræ in a digitated manner. From thence it runs obliquely inward toward the lateral parts of the bodies of the vertebræ, passes on the fore-side of the first and second, without being inserted in them; and, approaching gradually towards the same muscle on the other side, it is inserted near it in the fore-part of the lower side of the apophysis basilaris, or great apophysis of the os occipitis.

### RECTUS ANTICUS BREVIS.

THIS is a small flat muscle, about the breadth of one finger, situated laterally on the anterior part of the body of the first vertebra. It is fixed below to the basis or root of the transverse apophysis of that vertebra, near the anterior eminence.

From thence it runs obliquely upward and inward to a transverse impression in the lower side of the apophysis basilaris of the occipital bone, immediately before the condyle on the same side, being covered by the rectus anticus longus.

### TRANSVERSALIS ANTICUS PRIMUS.

THIS is a small, pretty thick, and wholly fleshy muscle, about the breadth of a finger, situated between the basis of the os occipitis and the transverse apophysis of the first vertebra. It is fixed by one end in the anterior part of that apophysis; and from thence running up a little obliquely, it is inserted, by the other end, in a particular impression, between the condyle of the os occipitis and the mastoid apophysis of the same side, behind the the apophysis styloides, and under the edge of the jugular fossula.

### TRANSVERSALIS ANTICUS SECUNDUS.

THIS is a small muscle, situated between the transverse apophyses of the first two vertebræ of the neck. It is fixed, by one extremity, very near the middle of the second apophysis, and, by the other, near the root or basis of the first; and therefore it is a muscle of the neck, rather than of the head.

### MUSCULI ACCESSORII.

WE sometimes meet with a small muscle, fixed, by one end, to the extremity of the first transverse apophysis of the neck, near the insertions of the two obliqui, from whence, running up obliquely, it is again inserted behind the mastoid apophysis. This muscle is commonly thought to be a third small transversalis on that side where it is found, but it seems rather to be an additional muscle to the obliquus superior.

*Uses of the Muscles which move the Head on the Trunk.*

THE action of the sterno-mastoidæ is different, according as either both muscles, or only one of them, acts,  
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and according to the different situation of the head and trunk.

When we keep the head and trunk streight, whether in standing or sitting, both muscles preserve the head in that posture against any force by which it would otherwise be moved backward.

One of these muscles acting alone, may have the same use, if the force to push the head back be applied between the anterior and lateral parts of it.

They both serve likewise to perform the rotations of the head, that is, to make it turn to either side as on a pivot; and, in this case, when we turn the head to one side, the sterno-mastoidæus on the other side acts, and not that on the same side.

They both serve, in the next place, to bring the head near the thorax when we lie on the back, or bend backward in sitting. In this case, the sternum, being the fixed point, must remain immoveable; but as its connection with the first rib, and the inflexibility of the cartilage of that rib, are not always sufficient for this, the muscoli recti of the abdomen must lend their assistance in great efforts.

The two splenii serve to support the head in an erect posture, whether in standing or sitting; to moderate the flexion of the head forward, and to bring it back again to its natural posture.

They serve alternately to co-operate with either of the sterno-mastoidæi, for the rotation of the head: Thus when the right sterno-mastoidæus turns the head, the left splenius corresponds with it by its upper part; while the lower part at the same time turns the vertebræ of the neck.

The complexi are assistants to the splenii, to keep the head streight in sitting or standing, to hinder it from inclining forward, and to raise it when inclined.

The recti majores, and minores postici, and obliqui superiores, turn the head a little backward on the first vertebra of the neck. The recti majores contribute most to this motion; and the minores seem likewise to hinder the articular membranes from being pinched between the bones in great motions.

The recti majores and minores antici, and the two transversales antici, move the head forward on the first vertebra; and the recti minores, and transversales breves, likewise defend the capsular ligaments.

The obliqui inferiores or majores are true rotators of the head, by turning the first vertebra upon the odontoid apophysis of the second; all which alternate motions the head follows, without being hindered in the motions forward and backward in any degree of rotation.

Of the transversales antici, the first only move the head in the manner above mentioned; neither can they perform any other motions, their insertions being confined to the os occipitis and first vertebra. The transversales antici secundi have no share in the particular motions of the head, but ought rather to be ranked among the muscles which move the vertebræ of the neck.

The complexi minores belong to the head only by their superior portions; the other portions belonging rather to the neck. They may serve alternately in the lateral motions of the head, and thereby co-operate with the splenii

nus and sterno-mastoidæus of the same side, when these two act together; and they may likewise be of use to preserve the capsular ligaments to which they adhere.

The small accessoriæ, when they are found, have the same uses with the muscles to which they are supernumerary.

## SECT. XV. *Of the Vertebral MUSCLES.*

### LONGUS COLLI.

THIS vertebral muscle is made up of several others, situated laterally along the fore-side of all the vertebræ of the neck, and some of the upper vertebræ of the back.

It may be divided into two portions; one superior, consisting of oblique converging muscles; and one inferior, composed of oblique diverging muscles.

The superior portion is covered by the rectus anticus longus of the head. The muscles, of which it consists, are fixed below to all the transverse apophyses that lie between the first vertebra and the last. From thence they run up obliquely, and are inserted in the anterior eminence of the first vertebra, and in the bodies of the three following.

The inferior portion appears almost straight, and yet all the muscles that compose it are diverging, or directed obliquely outward. They are fixed below to the anterior lateral part of the body of the last vertebra of the neck, and of the first three of the back, and sometimes of more. From thence they run upward, and a little obliquely outward, and are inserted near the transverse apophyses of all the vertebræ of the neck, except the first and last.

### TRANSVERSALIS COLLI MAJOR.

THIS is a long thin muscle, placed along all the transverse apophyses of the neck, and the four, five, or six upper apophyses of the back, between the complexus major and minor.

It is composed of several small muscular fasciculi, which run directly from one or more transverse apophyses, and are inserted sometimes in the apophysis nearest to these, sometimes in others more remote, the several fasciculi crossing each other between the insertions of the two complexi, which are likewise crossed by them.

### TRANSVERSALIS GRACILIS *sive* COLLATERALIS COLLI.

THIS is a long thin muscle, resembling the transversalis major in every thing but size, and situated on the side of that muscle.

### SEMI-SPINALIS *sive* TRANSVERSO-SPINALIS COLLI.

THIS name is given to all that fleshy mass which lies between the transverse and spinal apophyses, from the second vertebra of the neck, to the middle of the back.

It is composed of several oblique converging mus-

cles, which may be divided into external and internal.

The external are fixed below to the transverse apophyses of the six, seven, eight, or nine upper vertebræ of the back, by tendinous extremities, which, as they ascend, become fleshy, and mix with each other. Their superior insertions in the neck are six in number, whereof the first, which is tendinous, is in the seventh spinal apophysis; the rest, which are fleshy, are in the five next spinal apophyses.

The internal are shorter and more oblique than the external, and partly covered by them. They are fixed, by their lower extremities, to the transverse apophyses of the three or four upper vertebræ of the back, and to the oblique apophyses of the four or five lower vertebræ of the neck; and, by their other extremities, they are inserted in the six spinal apophyses of the neck.

### SPINALES COLLI MINORES.

THESE muscles lie between the six spinal apophyses of the neck, and between the last of the neck and first of the back, being inserted in these apophyses, by both extremities, on one side of the posterior cervical ligament, which parts them from those on the other side.

### TRANSVERSALES COLLI MINORES.

THESE are very small short muscles, found in the interstices of several transverse apophyses in which they are inserted. They are likewise termed *inter-transversales*.

### SACRO-LUMBARIS.

THIS is a long complex muscle, narrow and thin at the upper part, broad and thick at the lower, representing a kind of flat pyramid. It lies between the spine and posterior part of all the ribs, and along the back-part of the regio lumbaris, all the way to the os sacrum.

Through all this space, it is closely accompanied by the longissimus dorsi, which lies between it and the spinal apophyses of the vertebræ; a narrow, fatty, or cellular line running between them.

It is fixed below, by a broad thin tendinous aponeurosis, to the superior spines of the os sacrum, and to the neighbouring lateral parts of that bone; and, lastly, to the external labium of the posterior part of the crista of the ilium, all the way to the great tuberosity.

From thence this muscle runs upward, and a little laterally, over all the regio lumbaris; the aponeurosis sending off, from its inside, a mass of fleshy fibres, which are divided, from below upwards, into several large fasciculi, inserted in all the transverse apophyses of the loins.

Afterwards it runs up obliquely over all the ribs; sometimes as high as the two or three lowest vertebræ of the neck, sometimes higher, and sometimes it ends at the first vertebra of the back.

### LONGISSIMUS DORSI.

THIS is a very complex, long, and narrow muscle, something

something like the sacro-lumbaris, but more fleshy and thicker, situated between the spinal apophyses and the muscle just mentioned, from which it is divided by a small, fatty, or cellular line; but at the lower part they are confounded together. It covers the semi-spinalis, or transverso-spinalis dorsi, and the semi-spinalis lumborum. Its upper part lies between the sacro-lumbaris and transversalis colli.

Its inferior insertions are partly by distinct tendinous portions, and by a broad aponeurosis common to it with the sacro-lumbaris; and partly by a large fasciculi of fleshy fibres, which, at first sight, seem to compose one uniform mass. It is fixed, by the long, flat, tendinous portions of different breadths, to the last spinal apophysis of the back, to all those of the loins, and to one or two of the superior spines of the os sacrum. These portions lie at different distances from each other, but are all connected by a thin aponeurosis fixed to their edges.

From thence they run up obliquely, diverging from the apophyses; and, beginning to be fleshy at their inner or anterior sides, they terminate above in small roundish tendons, inserted in the extremities of the seven upper transverse apophyses of the back, and in the neighbouring ligaments of all the true ribs.

The other inferior insertion wholly fleshy, is partly in the inner or fore-side of the aponeurosis of the sacro-lumbaris, and partly in the upper portion of the os sacrum, being from thence continued to the great tuberosity of the os ilium.

From thence this uniform mass of fleshy fibres runs up in a course almost direct, crossing the tendinous portions which are more oblique; and join the inferior fibres of the sacro-lumbaris by large fasciculi inserted in the transverse and oblique apophyses of the vertebræ of the loins. The fibres of this portion go afterwards to the ribs, being inserted by planes more or less fleshy, in the lower convex edge of all the false ribs, between the condyles or tuberosities and the angles.

At the sixth or seventh vertebræ of the back, one or more of the tendinous portions often communicate with some fasciculi of the semi-spinalis, or transverso-spinalis dorsi.

### SPINALIS DORSI MAJOR.

This is a pretty long and slender muscle, lying up on the lateral part of the extremities of the spinal apophysis of the back.

It is composed of several muscular fasciculi of different lengths, which, crossing each other, are inserted laterally by small tendons in the spinal apophyses from the second, third, or fourth vertebræ of the back; and sometimes, though seldom, from the last of the neck, or first of the back, all the way to the first or second vertebræ of the loins, with several irregular decussations, which vary in different subjects.

### SPINALES DORSI MINORES.

These muscles are of two kinds. Some go laterally from the extremity of one spinal apophysis to another;

being often mixed with the short fasciculi of the spinalis major. The rest lie directly between the extremities of two neighbouring spinal apophyses, being separated from their fellows on the other side by the spinal ligament. They are smaller and thinner than those of the neck, and are properly enough termed *inter-spinales*.

### TRANSVERSALES DORSI MINORES.

SOME particular muscles of this kind are found fixed to the extremities of the three lowest transverse apophyses of the back. The rest are all in some measure continuations of the transversalis major.

### SEMI-SPINALIS *five* TRANSVERSO-SPINALIS DORSI.

THIS is a fleshy mass, which, from all the spinal and transverse apophyses of the back and loins, is extended into distinct fasciculi over the vertebræ themselves.

It is made up, like that of the neck, of several oblique converging vertebral muscles, the uppermost of which is fixed below to the third transverse apophysis of the back, and above to the first spinal apophysis. The lowest is fixed below to the third transverse apophysis of the loins, and above to the last spinal apophysis of the back.

They may be divided into external, which are first discovered; and internal, which lie immediately on the vertebræ. The external, from the first vertebræ to the seventh, inclusively, appear to be longer than the internal, which are covered by them.

### TRANSVERSO-SPINALIS LUMBORUM, SACRÆ VETERIBUS.

THIS muscle is composed of several oblique converging or transverso-spinal muscles, in the same manner as in the back and neck; and it lies between the spinal and oblique apophyses of the loins, reaching to the os sacrum.

The lowest of these muscles are fixed to the superior lateral parts of the os sacrum, to the ligamentum sacro-iliacum, and to the posterior superior spine of the os ilium. The rest are fixed to the three lowest transverse apophyses, and to the four lowest oblique apophyses of the loins, and to their lateral tuberosities. From thence they run up to all the spinal apophyses of these vertebræ; the external, or those that appear first, being longer than the internal, which lie immediately on the vertebræ, especially toward the lower part.

### SPINALES & TRANSVERSALES LUMBORUM.

THERE are some fasciculi which run up from the superior false spines of the os sacrum, to the lower spinal apophyses of the loins, which may be looked upon as so many spinales lumborum majores. There are likewise some spinales minores between the spinal apophyses of the loins, and transversales minores between the transverse apophyses, which are sometimes of a considerable breadth.

### QUADRATUS

**QUADRATUS LUMBORUM sive LUMBARIS EXTERNUS.**

THIS is a small, oblong, flat muscle, irregularly square, narrower at its upper than at its lower part, lying along the sides of the vertebræ lumborum, between the last false rib and the os ilium.

It is fixed below to the external labium of almost all the posterior half of the crista ossis ilium, to the ligamentum sacro-iliacum, and a little to the os sacrum, by a fleshy plane, the fibres whereof run obliquely backward.

From thence it runs up between the sacro-lumbaris and psoas, by both which it is partly hid, and is inserted in the extremities of all the transverse apophyses of the loins by oblique tendinous digitations. It is likewise fixed by a broad insertion in the twelfth rib, on the inside of the ligament that lies between it and the longissimus dorsi, by which that rib is connected to the first vertebra of the loins.

**MUSCULI OSSIS COCCYGIS.**

THESE are small, thin, radiated muscles, lying on the inner or concave side of the os sacrum, and neighbouring parts of the pelvis. They are four in number, two on each side, whereof one is placed more forward, the other more backward; for which reason the first may be termed *coccygæus anterior, sive ischio-coccygæus*; the other *coccygæus posterior, sive sacro-coccygæus*.

The coccygæus anterior is fixed by a broad insertion in the anterior portion of the small transverse ligament, at the upper part of the foramen ovale of the os innominatum, which is no more than a particular fold of the great transverse ligament of the pelvis. From thence it runs between this great ligament and the musculus obturator internus, and, contracting in breadth, it is inserted in the lower part of the os coccygis.

The coccygæus posterior, or sacro-coccygæus, is fixed to the inner or concave edge of the two first vertebræ of the os sacrum, to the inner and lower edge of the ligamentum sacro-sciaticum, and to the spine of the os ischium. From thence, contracting in breadth, it is inserted in the inside of the os coccygis above the former muscle.

**PSOAS PARVUS.**

THIS is a long slender muscle, lying upon the psoas major.

It is fixed above by a short tendon, sometimes to the last transverse apophysis of the back, or higher; sometimes to the first of the loins, and sometimes to both. From thence it runs down wholly fleshy, and more or less complex, on the great psoas, in a direction a little oblique.

Having reached the middle of the regio-lumbaris, or thereabouts, it forms a slender flat tendon, which gradually increasing in breadth, like a thin aponeurosis, runs over the psoas major and iliacus internus, at their union, and from thence down to the symphysis of the os pubis and os ilium, and is inserted chiefly in the crista of the os pubis, above the insertion of the pectineus, sometimes sending an aponeurotic lamina further down.

*USES of the Muscles which move the Vertebrae.*

THE scaleni, when they act on each side at the same time, may assist in bringing the neck forward, when we lean back in any respect. When those of one side act by themselves, they make a lateral inflection, either of all the vertebræ of the neck together, as in bending the middle of the neck; or of some only, as in bending the lower part of the neck alone.

The longi colli bring the neck forward by the lower part of their inferior portions. When one of them acts alone, or acts more than the other, this motion is more or less oblique.

By the upper and greatest part of the lowest portion, they counterbalance the posterior muscles of these vertebræ, and hinder the neck from bending backward by the contraction of the sterno-mastoidæi, when, lying on the back, we raise the head.

The transversalis major, transversalis gracilis, and the little transversales, acting on one side, can have no other use but to bend the neck laterally, and to hinder these inflexions when they act on both sides.

The semi-spinales or transverso-spinales of both sides acting together, extend the neck upon the trunk, to keep it from inclining forward in standing or sitting, and bend it backward. The semi-spinales of one side acting alone, produce the same motions in an oblique direction; and in that case they are assisted by the inferior or vertebral portion of the neighbouring splenius, under which they cross.

The semi-spinales of both sides may likewise serve for the rotation of the neck, but then the inferior splenius of the opposite side must assist them.

The inter-spinales are assistants to the semi-spinales in their mutual action, and may likewise serve to bring back the neck to its natural situation, after small motions of rotation.

The vertebræ of the back are moved by being bent forward, by being extended or straightened, and by being inflected directly or obliquely toward each side. The motion of rotation has no place here, because of the particular structure of the joints of these vertebræ, and their connexion with the ribs, which likewise hinder the flexion backward. Flexion and extension are the two principal motions, and much more apparent than the others.

The flexion of the back forward is not performed by any particular muscles, but depends, both in standing and sitting, on the relaxation of the muscles that extend or straighten it, and keep it in that erect posture.

The two sacro-lumbares maintain the back and the regio-lumbaris in their natural situation when we stand or sit; and by the relaxation of their fibres more or less, the trunk is proportionably bent forward by the weight of the head and breast. They likewise extend the back and loins in all postures, keep them steady and fixed under the weight of burdens, and bend the loins backward.

The longissimus dorsi is an assistant to the sacro-lumbaris, especially to the vertebral portion of that muscle, which it helps very powerfully, both by the multiplicity and insertion of its fibres, in sustaining the vertebræ of the



the back and loins while extended, whether in sitting or standing, and in preventing their sinking under the weight of the body, or of any additional burden. It assists in performing and in counterbalancing all the motions and inflexions of which these vertebræ, especially those of the loins, are capable in all postures of the body.

All the spinales and transversales of the back and loins belonging to the class of the vertebrales recti, the spinates to the middle muscles, and the transversales to the lateral, their chief uses must be to assist, moderate, and maintain the motions of extension and lateral inflexion, whether simple and direct, or oblique and compound.

The semi-spinales, or transverso-spinales, being oblique, converging, vertebral muscles, are assistants to the sacro-lumbaris and longissimus dorsi, which they cross on each side.

The quadratus lumborum and psoas parvus are of the same use to the vertebræ of the loins, as the scaleni to those of the neck. When both quadrati act, they keep the lumbar pillar straight, that is, so as not to incline to either side, and then they may assist the recti of the abdomen in the inflexions forward, and the superior portions of the obliqui in lateral inflexions.

They may likewise serve to support the haunches alternately in walking; and, in standing on one foot, the quadratus of the opposite side may support the haunch of that side.

The psoas parvus, serves to sustain the pelvis much in the same manner with the muscoli recti of the abdomen; in climbing, &c.

The coccygæus anterior may sustain the coccyx in æquilibrio, and hinder it from being bent backward, and from being luxated in great strains, as in the excretion of hardened feces, &c.

The coccygæus posterior can only serve to replace the os coccygis when it has been forced backward, and to hinder it from being luxated backward.

## SECT. XVI. *The MUSCLES which move the Lower Jaw.*

### MASSETER.

THIS is a very thick fleshy muscle, situated at the back part of the cheek. It seems to be made up of three portions, like a triceps, viz. one large and external portion, one middle, and one small and internal.

The external portion is fixed by one tendinous extremity to all the inferior edge of the os maxillæ, and a little to the neighbouring parts of the os maxillare and apophysis zygomatica of the os temporum. From thence it runs down obliquely backward, being wholly fleshy, and is inserted by the other extremity in the rough impression on the outside of the angle of the lower jaw.

The middle portion is fixed by one end to the lower edge of the whole apophysis zygomatica of the os temporum, and a very little to that of the os maxillæ. From thence it runs down a little obliquely forward in an opposite direction to the first portion, under which it crosses.

It is inserted by its other extremity in the middle of the inside of the ramus of the lower jaw, near the insertion of the external portion with which it mixes.

The third portion, which is least and most internal; is fixed by one extremity to the inner labium of the lower edge, and also to the inside of almost all the zygomatic arch; and by the other, to the root or basis of the coronoid apophysis, where it mixes wholly fleshy with the insertion of the middle portion.

### TEMPORALIS.

THIS is a broad flat muscle, resembling the quadrant of a circle in figure. It occupies all the semi-circular or semi-oval plane of the lateral region of the cranium, the temporal fossa, and part of the zygomatic fossa. From this situation it has its name.

To conceive justly the insertions of this muscle, it must be observed, that the pericranium is divided into two laminae. The internal lamina, sometimes taken for a particular periosteum, covers immediately all the bony parts of this region. The external lamina separated from the other, is spread out like an aponeurotic or ligamentary tent, by means of its adhesions to the external angular apophysis of the os frontis, to the posterior edge of the superior apophysis of the os maxillæ, and to the upper edge of all the zygomatic arch, all the way to the root of the mastoid apophysis.

This muscle is composed of two planes of fleshy fibres, fixed to the two sides of a tendinous plane nearly of the same breadth with them, like a concealed middle tendon; as may be plainly seen by dividing the muscle all the way to the bone, according to the direction of its fibres. The body of the muscle thus formed is inclosed between the two aponeurotic or ligamentary laminae in the following manner.

The internal fleshy plane is fixed, by a broad radiated insertion, to all the semi-circular plane of the cranium, by the intervention of the internal lamina of the periosteum.

Thus it is fixed to the lateral external part of the os frontis, and to its external angular apophysis, to the lower part of the os parietale, to the squamous portion of the os temporis, to the great ala or temporal apophysis of the sphenoidal bone, by which the temporal fossa is formed; and a little to the backside of the internal orbital apophysis of the os maxillæ, which forms part of the zygomatic fossa.

### PTERYGOIDÆUS MAJOR *five* INTERNUS.

THIS muscle lies on the inside of the lower jaw, almost in the same manner as the masseter does on the outside, being of the same figure with that muscle, only smaller and narrower.

It is fixed above in the pterygoid cavity, chiefly to the inside of the external ala of the apophysis pterygoides.

It runs down obliquely toward the angle of the lower jaw, and is inserted a little tendinous in the inequality

ties on the inside thereof, opposite to the insertion of the masseter.

#### PTERYGOIDÆUS MINOR *sive* EXTERNUS.

THIS is an oblong fleshy muscle, much smaller than the other, and situated almost horizontally between the outside of the apophysis pterygoidea, and the condyloid apophysis of the lower jaw, the subject being considered in an erect posture.

It is fixed by one extremity to the outside and edge of the outer ala of the pterygoid apophysis, filling the fossula which is at the basis of this apophysis, near the basis of the temporal apophysis, of the sphenoidal bone.

From thence it runs backward, and a little outward, into the void space between the two apophyses of the lower jaw, and is inserted anteriorly in the condyloid apophysis, at a small fossula immediately under the inner angle of the condyle. It is also fixed to the capsular ligament of the joint.

#### DIGASTRICUS.

THIS is a small long muscle, situated laterally between the whole basis of the jaw and the throat. It is fleshy at both extremities, and tendinous in the middle, as if it consisted of two small muscles joined endwise by a tendon, and from thence it is called *digastricus* in Greek, and *biventer* in Latin.

It is fixed by one fleshy extremity in the sulcus of the mastoid apophysis. From thence it runs forward, inclining towards the os hyoides, where the first fleshy body ends in a round tendon, which is connected to the lateral part and root of the cornua of that bone by a kind of aponeurotic ligament, and not by a vagina or pulley.

Here the tendon is incurvated, and presently ends in the other fleshy body, which is fixed immediately above the internal labium of the basis of the chin near the symphysis, in a small unequal depression. This insertion is broader than that of the other extremity.

#### Uses of the Muscles which move the Lower Jaw.

THE two temporales acting together, raise the lower jaw, press the teeth in that jaw against the upper teeth, and pull it back when it has been carried so far forward as that the lower incisors get before the upper. They perform the last motion by their most posterior portion, which passes over the root of the zygomatic apophysis, and the other motions by the co-operation of all their muscular radii.

The two masseters serve to raise the lower jaw, and to push the lower teeth against the upper, in which use they co-operate with the temporales. They likewise bring this jaw forward by their external and largest portion; draw it back by their middle portion; and move it laterally by their superior portions acting alternately. By the co-operation of all the three portions, they press the lower teeth against the upper.

Both pterygoidei interni serve to raise the lower jaw, to bring the lower teeth near the upper, and to move the jaw laterally, as in grinding the food.

The two pterygoidei externi bring the lower jaw forward, in order to set the lower incisors before the upper; in which action they are antagonists to the posterior portion of the temporales, and the great portion of the masseters. When one of them acts, it carries the chin obliquely forward, or turns it toward the other sides. This oblique motion is performed alternately by these two muscles acting singly.

The two digastrici serve to depress the lower jaw, and to open the mouth.

The force of these muscles is very considerable, as may be shewn by laying the elbow on a table, and leaning with the chin on the hand, while we endeavour at the same time to depress the lower jaw; for as in that case this jaw cannot descend, the digastrici, by their insertions in the apophysis mastoidea, raise the upper jaw, by bending the head backward on the condyles of the lower jaw.

#### SECT. XVII. The MUSCLES which move the Os Hyoides.

##### MYLO-HYOIDÆUS.

THIS is a broad, thin, pennisiform muscle, situated transversely between the internal lateral parts of the basis of the lower jaw, and lying on the anterior portions of the two digastric muscles.

It is made up of two equal fleshy portions, one lying on the right side, the other on the left, both in the same plane, and joined to a small middle tendon, which is inserted anteriorly in the middle of the basis of the os hyoides, and from thence runs directly forward, diminishing gradually in its course.

Each portion is fixed, by fleshy fibres, to the internal lateral part of the lower jaw, between the oblique prominent line and the basis, under the first four dentes molares and caninus. The anterior and greatest part of the other fibres of each portion run obliquely from before backward, to the middle tendon, in which they are regularly fixed, the anterior fibres being the shortest, and a small triangular void space being formed between them and the symphysis of the chin.

The posterior fibres of each portion, which make about a fourth part of the whole, run likewise on each side to the basis of the os hyoides, and are inserted along the lower edge of its anterior or convex side, and from thence a little upward.

##### GENIO-HYOIDÆUS.

THIS is a small and pretty long fleshy muscle, situated between the symphysis of the chin and the os hyoides, close by its fellow.

It is fixed, by its anterior extremity, to a rough, and sometimes prominent surface, on the inner or posterior side of the symphysis of the lower jaw, a little above the chin. From thence it runs backward, and is inserted anteriorly in the upper edge of the basis of the os hyoides.

des, having first sent off a small lateral portion, which is fixed a little higher to the root of the cornu.

### STYLO-HYOIDÆUS.

THIS is a small fleshy muscle, lying obliquely between the apophysis styloides and os hyoides.

It is fixed laterally, by one extremity, to the root or basis of the apophysis styloides, and, by the other, to the os hyoides, at the place where the basis and cornu unite, and likewise to the cornu itself, from whence it has been called *stylo-cerato-hyoidæus*.

### OMOPLATO-HYOIDÆUS *five* OMO-HYOIDÆUS *vulgo* CORACO-HYOIDÆUS.

THIS is a very long small muscle, much narrower than the sterno-hyoidæus, and situated obliquely on the side of the neck or throat, between the scapula and os hyoides.

It is commonly fixed, by the lower extremity, to the superior colla of the scapula, between the small notch and the angle, and sometimes very near the angle.

From thence it passes over the coracoid apophysis, adhering sometimes to it by a kind of aponeurosis, or membranous ligament, and from this adhesion the name of *coraco-hyoidæus* was given it by some who had not discovered its main insertion.

It is likewise often fixed to the clavícula by ligamentary or fleshy fibres; and has sometimes been seen inserted in the whole middle portion of that bone, being inseparably united with the sterno-hyoidæus.

Having passed the clavicle, it is bent forward, and runs between the sterno-mastoidæus and internal jugular vein, the small middle tendon being situated in this place. From thence it runs up to its insertion in the inferior lateral part of the basis of the os hyoides, near the cornu, and insertion of the sterno-hyoidæus, which it covers a little.

### STERNO-HYOIDÆUS *five* STERNO-CLAVICO-HYOIDÆUS.

THIS is a long, thin, flat muscle, broader at the lower than at the upper part, and situated, together with its fellow, on the fore-side of the throat.

It is fixed, by its lower extremity, in the superior and lateral part of the inner or posterior side of the sternum, in the posterior part of the sternal extremity of the clavícula, in the transverse ligament which connects these two bones, and in the inner or back-side of the cartilage of the first rib. All these other insertions are more considerable than that in the sternum, which is sometimes scarce perceivable.

From thence it runs up on the fore-side of the aspera arteria, joined to its fellow by a membrane, which forms a sort of linea alba, and is inserted laterally in the lower edge of the basis of the os hyoides.

*Uses of the Muscles which move the Os Hyoides.*

THE mechanism observed in the motions of the os hy-

oides, as well as in those of the scapula, is very particular, and very different from what we find in all the other bones of the human body. All these bones have solid fulcra, on which they are either moved or kept fixed by the proper muscles, after the manner of a lever or otherwise; whereas the os hyoides is merely suspended, having nothing to fix it but these very muscles which move it in different manners.

The mylo-hyoidæus represents a moveable floor or bed, which sustains the tongue with its muscles and glands, and forms the bottom of the cavity of the mouth. When the two portions of this muscle act together, they draw the os hyoides a little forward, and fix it in that situation, raising the whole tongue at the same time, and compressing the glandulæ sub-linguales. If one lateral portion acts more than the other, it puts the os hyoides in an oblique situation, and in a condition to serve as a fixed point for the motions of the tongue.

The genio-hyoidæi pull the os hyoides much more forward than the mylo-hyoidæus; and as they are very narrow, and closely united together, there seems to be very little occasion for one of them to act without the other.

The stylo-hyoidæi move the os hyoides upward and backward in a middle direction, between those in which they lie; and they draw it more upward and backward when they act freely; that is, without being checked or confined by other muscles, in the manner which we shall see hereafter. When one acts more than the other, the bone is moved obliquely.

The omo-hyoidæi, or coraco-hyoidæi, act as the stylo-hyoidæi, in a middle direction between the oblique directions in which they lie, and draw the os hyoides downward and backward, when they are not counterbalanced by the stylo-hyoidæi. When one acts more than the other, the bone is drawn obliquely to the right or left-hand.

When these muscles and the stylo-hyoidæi act together, the os hyoides is drawn backward by a direct motion compounded of four oblique motions. This compound motion is directed more upward or more laterally, according to the degree of action of the stylo-hyoidæi, or omo-hyoidæi, or of any one muscle of each pair; and in all these motions the four muscles are counterbalanced by the genio-hyoidæi.

The sterno-hyoidæi draw the os hyoides directly downward, and serve to counterbalance the different motions of the stylo-hyoidæi, omo-hyoidæi, and genio-hyoidæi. They may, in some cases, be assisted by the sterno-thyroidæi, and thyro-hyoidæi, as we shall see hereafter.

According to the method commonly observed in complete treatises of myology, the following muscles remain still to be described, *viz.* The muscles of the forehead, occiput, palpebræ, eye, external ear, nose, lips, tongue, uvula, ductus Eustachianus, pharynx, larynx, parts of generation, anus, and bladder; and to these we ought even to add the heart, as Mr. Cowper has done in the late edition of his Myotomy. But the description of these will be better understood when we treat of the parts to which they belong. See Part VI.

## EXPLANATION OF PLATE XV.

FIG. 1. The MUSCLES immediately under the common teguments on the anterior part of the body, are represented on the right side; and on the left side the MUSCLES are seen which come in view when the exterior ones are taken away.

A, The frontal muscle. B, The tendinous aponeurosis which joins it to the occipital; hence both named *occipito-frontalis*. C, Attolens aurem. D, The ear. E, Anterior auris. FF, Orbicularis palpebrarum. G, Levator labii superioris alæque nasi. H, Levator labiorum communis. I, Zygomaticus minor. K, Zygomaticus major. L, Masseter. M, Orbicularis labiorum. N, Depressor labii inferioris. O, Depressor labiorum communis. P, Buccinator. QQ, Platysma myoides. R R, Sterno-cleido mastoideus. S, Part of the trapezius. T, Part of the scaleni.

SUPERIOR EXTREMITY.—U, Deltoides. V, Pectoralis major. W, Part of the latissimus dorsi. XX, Biceps flexor cubiti. YY, Part of the brachizus externus. ZZ, The beginning of the tendinous aponeurosis, (from the biceps) which is spread over the muscles of the fore-arm. a a, Its strong tendon inserted into the tubercle of the radius. b b, Part of the brachizus internus. c, Pronator teres. d, Flexor carpi radialis. e, Part of the flexor carpi ulnaris. f, Palmaris longus. g, Aponeurosis palmaris. 3, Palmaris brevis. 1, Ligamentum carpi annulare. 2 2, Abductor minimi digiti. h, Supinator longus. i, The tendons of the three extensors of the thumb. k, Abductor pollicis. l, Flexor pollicis longus. m m, The tendons of the flexores digitorum communi.—The sheaths are entire in the right hand,—in the left cut open, to shew the tendons of the flexor profundus perforating the sublimis.

MUSCLES not referred to—in the left superior extremity.—n, Pectoralis minor, seu serratus anticus minor. o, The two heads of (x x) the biceps. p, Coraco-brachialis. q q, The long head of the triceps extensor cubiti. r r, Teres major. f f, Subscapularis. t t, Extensores radiales. u, Supinator brevis. v, The cut extremity of the pronator teres. w, Flexor digitorum sublimis. x, Part of the flexor profundus. y, Flexor pollicis longus. z, Part of the flexor pollicis brevis. 4, Abductor minimi digiti. 5, The four lumbricales.

TRUNK.—6, Serrated extremities of the serratus anticus major. 7 7, Obliquus externus abdominis. 8 8, The linea alba. 9, The umbilicus. 10, Pyramidalis. 11 11, The spermatic cord. On the left side, it is covered by the cremaster. 12 12, Rectus abdominis. 13, Obliquus internus. 14 14, &c. Intercostal muscles.

INFERIOR EXTREMITIES.—a a, The gracilis.

b b, Parts of the triceps. c c, Pectineus. d d, Psoas magnus. e e, Iliacus internus. f, Part of the glutæus medius. g, Part of the glutæus minimus. h, Cut extremity of the rectus cruris. i i, Vastus externus. k, Tendon of the rectus cruris. l l, Vastus internus. \* Sartorius muscle. \* \* Fleshy origin of the tensor vaginæ femoris or membranofus. Its tendinous aponeurosis covers (i), the vastus externus in the right-side. m m, Patella. n n, Ligament or tendon from it to the tibia. o, Rectus cruris. p, Crureus. q q, The tibia. r r, Part of the gemellus or gastrocnemius externus. s s s, Part of the soleus or gastrocnemius internus. t, Tibialis anticus. u, Tibialis posticus. v v, Peronæi muscles. w w, Extensor digitorum longus communis. x x, Extensor pollicis longus. y, Abductor pollicis.

FIG. 2. The MUSCLES, GLANDS, &c. of the left side of the face and neck, after the common teguments and platysma myoides have been taken off.

a, The frontal muscle. b, Temporalis and temporal artery. c, Orbicularis palpebrarum. d, Levator labii superioris proprius. e, Levator labiorum communis. f, Zygomaticus. g, Depressor labii inferioris proprius. h, Depressor labiorum communis. i, Buccinator. k, Masseter. l l, Parotid gland. m, Its duct. n, Sterno-cleido mastoideus. o, Part of the trapezius. p, Sterno-hyoidæus. q, Sterno-thyroideus. r, Omo-hyoidæus. s, Levator scapulæ. t t, Scaleni. u, Part of the splenius.

FIG. 3. The MUSCLES of the face and neck, in view after the exterior ones are taken away.

a a, Corrugator superciliorum. b, Temporalis. c, Tendon of the levator palpebræ superioris. d, Tendon of the orbicularis palpebrarum. e, Masseter. f, Buccinator. g, Levator labiorum communis. h, Depressor labii superioris proprius. i, Sphincter oris. k, Depressor labiorum communis. l, Muscles of the os hyoides. m, Sterno-cleido mastoideus.

FIG. 4. Some of the MUSCLES of the os hyoides, and submaxillary gland.

a, Part of the masseter muscle. b, Posterior head of the digastric. c, Its anterior head. d d, Sterno-hyoidæus. e, Omo-hyoidæus. f, Stylo-hyoidæus. g, Submaxillary gland in situ.

FIG. 5. The submaxillary gland and duct.

a, Musculus mylo-hyoidæus. b, Hyo-glossus. c, submaxillary gland extra situ. d, Its duct.

EXPLA-

Fig. 1.

Fig. 2.

Fig. 3.

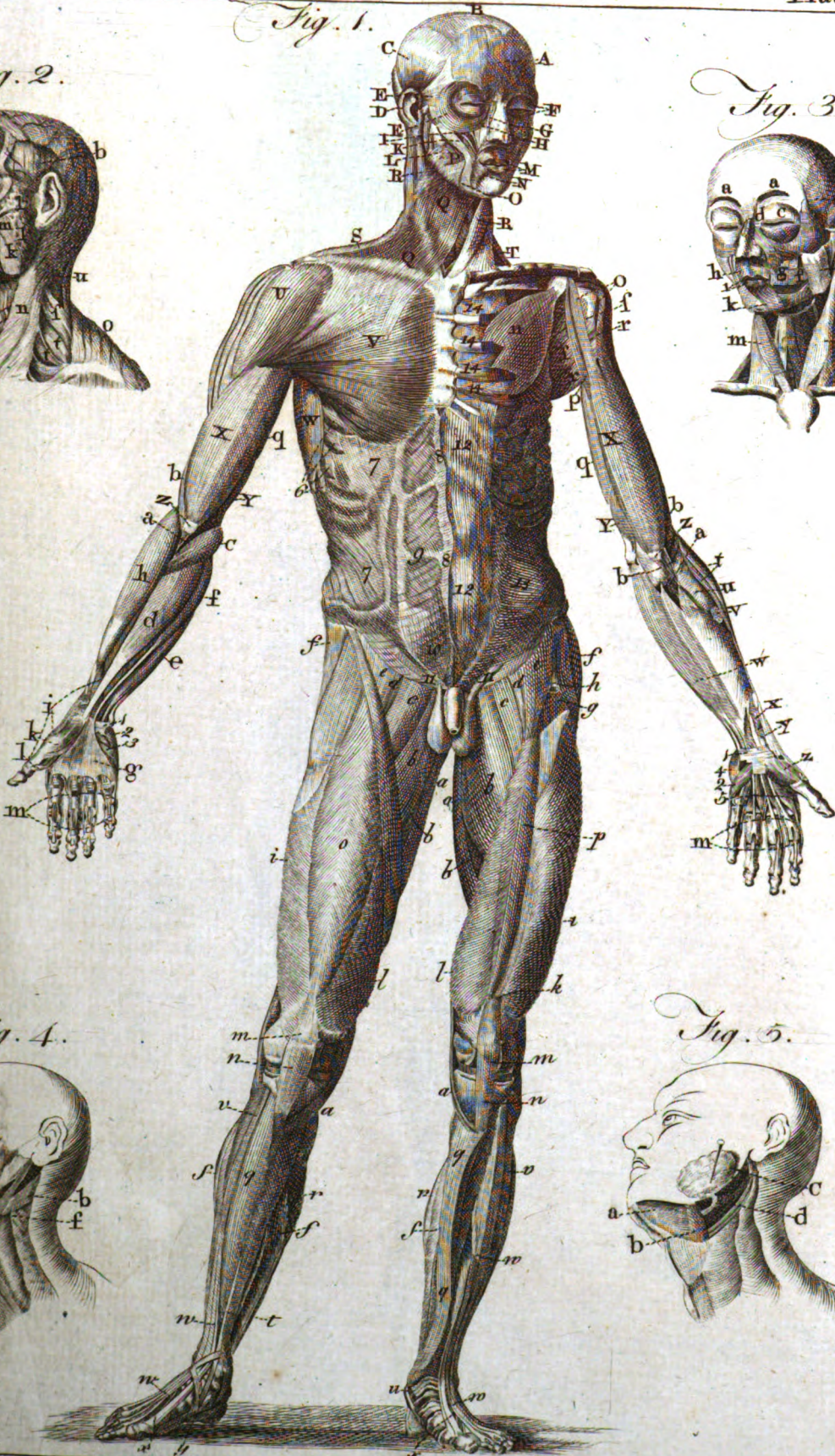
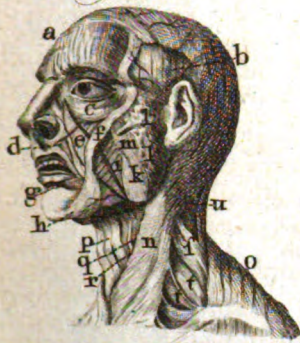


Fig. 4.

Fig. 5.

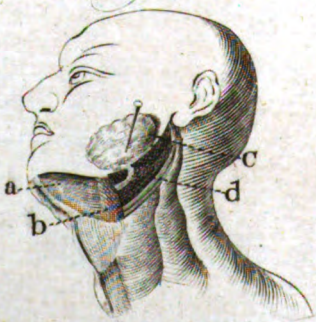






Fig. 2.

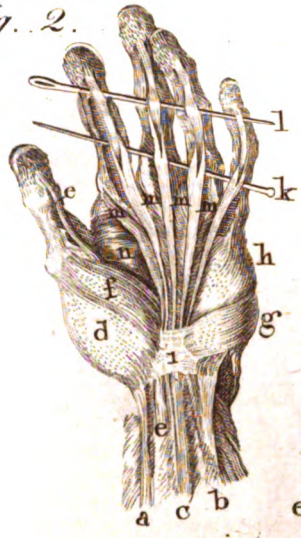


Fig. 1.

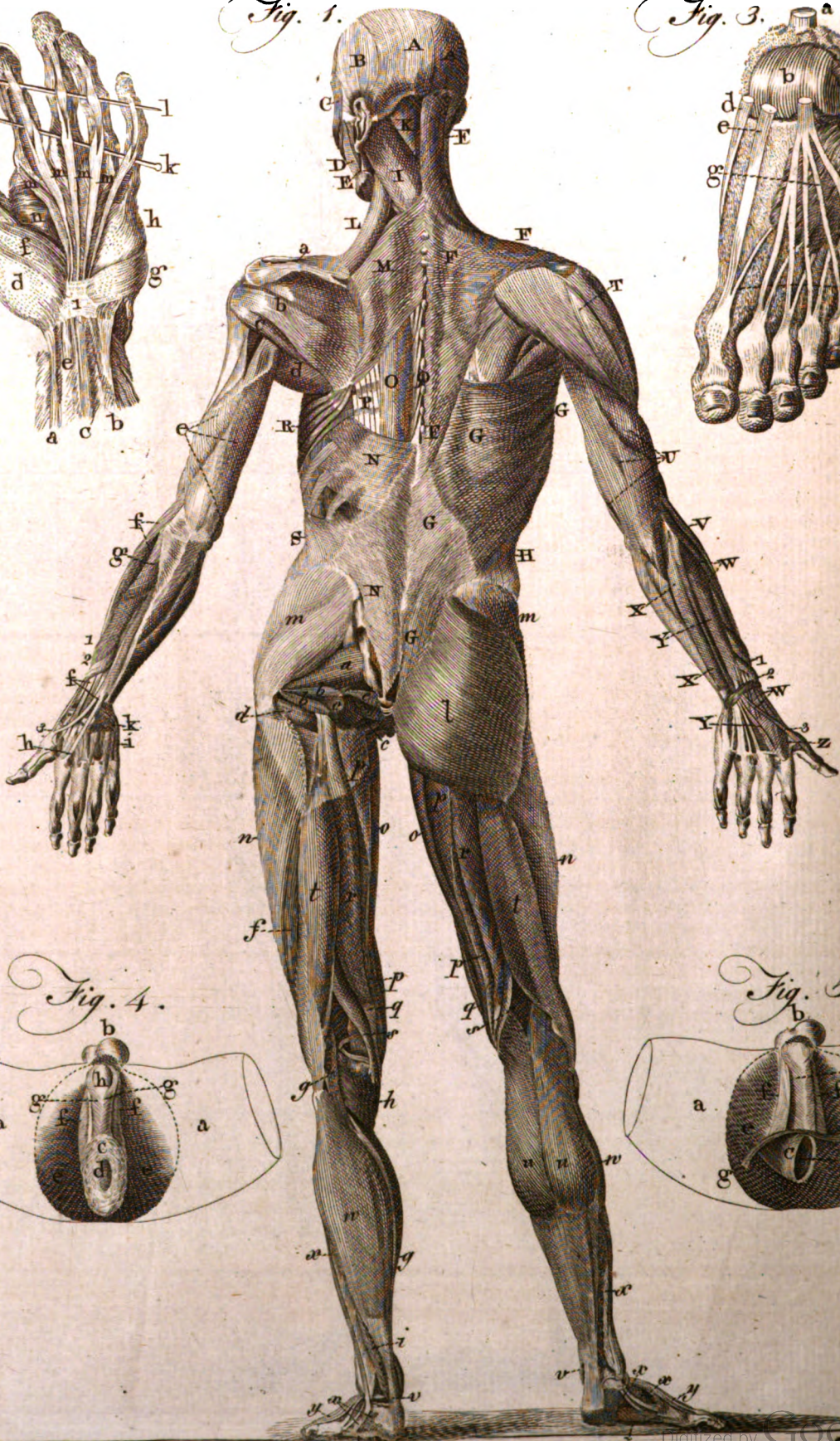


Fig. 3.



Fig. 4.

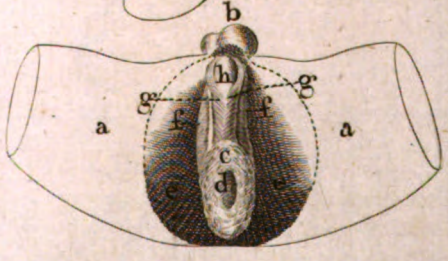
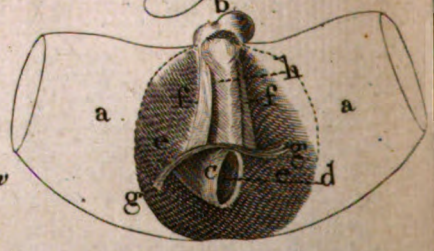


Fig. 5.





## EXPLANATION OF PLATE XVI.

FIG. 1. The **MUSCLES** immediately under the common teguments on the posterior part of the body are represented in the right side;—and on the left side the **MUSCLES** are seen which come in view when the exterior ones are taken away.

**HEAD.**—A A', Occipito-frontalis. B, Attollores aurem. C, Part of the orbicularis palpebrarum. D, Maffeter. E, Pterygoideus internus.

**TRUNK.**—Right side. F F F, Trapezius seu cucullaris. G G G G, Latissimus dorsi. H, Part of the obliquus externus abdominis.

**TRUNK.**—Left side. I, Splenius. K, Part of the complexus. L, Levator scapulæ. M, Rhomboides. N N, Serratus pectus inferior. O, Part of the longissimus dorsi. P, Part of the sacro-lumbaris. Q, Part of the semi-spinalis dorsi. R, Part of the serratus anticus major. S, Part of the obliquus internus abdominis.

**SUPERIOR EXTREMITY.**—Right side. T, Deltoïdes. U, Triceps extensor cubiti. V, Supinator longus. W W, Extensores carpi radialis longior & brevior. X X, Extensor carpi ulnaris. Y Y, Extensor digitorum communis. Z, Abductor indicis. 1 2 3, Extensores pollicis.

**SUPERIOR EXTREMITY.**—Left side. a, Supra-spinatus. b, Infra-spinatus. c, Teres minor. d, Teres major. e, Triceps extensor cubiti. f f, Extensores carpi radialis. g, Supinator brevis. h, Indicator. i 2 3, Extensores pollicis. i, Abductor minimi digiti. k, Interossei.

**INFERIOR EXTREMITY.**—Right side. l, Gluteus maximus. m, Part of the gluteus medius. n, Facialis. o, Gracilis. p p, Adductor femoris magnus. q, Part of the vastus internus. r, Semimembranosus. s, Semitendinosus. t, Long head of the biceps flexor cruris. u u, Gastrocnemius externus seu gemellus. v, Tendo Achillis. w, Soleus seu gastrocnemius internus. x x, Peronæus longus & brevis. y, Tendons of the flexor digitorum longus;—and under them \* flexor digitorum brevis. z, Abductor minimi digiti.

**INFERIOR EXTREMITY.**—Left side. m, n, o, p p, q, r r, s, t, v, w w, x x, y, z. Point the same

parts as in the right side. a, Pyriformis. b b, Gemini. c c, Obturator internus. d, Quadratus femoris. e, Coccygæus. f, The short head of the biceps flexor cruris. g g, Plantaris. h, Popliteus. i, Flexor pollicis longus.

FIG. 2. The palm of the left hand after the common teguments are removed, to shew the **MUSCLES** of the fingers.

a, Tendon of the flexor carpi radialis. b, Tendon of the flexor carpi ulnaris. c, Tendons of the flexores digitorum. d, Abductor pollicis. e e, Flexor pollicis longus. f, Flexor pollicis brevis. g, Palmaris brevis. h, Abductor minimi digiti. i, Ligamentum carpi annulare. k, A probe put under the tendons of the flexor digitorum sublimis; which are perforated by l, the flexor digitorum profundus. m m m m, Lumbricales. n, Adductor pollicis.

FIG. 3. A fore-view of the foot and tendons of the flexores digitorum.

a, Cut extremity of the tendo Achillis. b, Upper part of the astragalus. c, Os calcis. d, Tendon of the tibialis anticus. e, Tendon of the extensor pollicis longus. f, Tendon of the peronæus brevis. g, Tendons of the flexor digitorum longus, with the nonus Vesalii. h h, The whole of the flexor digitorum brevis.

FIG. 4. **MUSCLES** of the Anus.

a a, An outline of the buttocks, and upper part of the thighs. b, The testes contained in the scrotum. c c, Sphincter ani. d, Anus. e, Levator ani. f f, Erector penis. g g, Accelerator urinæ. h, Corpus cavernosum urethræ.

FIG. 5. **MUSCLES** of the Penis.

a a, b, d, e e, f f, h, point the same as in fig. 4. c, Sphincter internus ani. g g, Transversus perinæi.

## PART III.

## OF THE ARTERIES.

THE heart throws the blood into two great arteries; one of which is named *aërta*, the other *arteria pulmonalis*.

The aorta distributes the blood to all the parts of the body, for the nourishment of the parts, and for the secretion of different fluids.

The arteria pulmonalis carries the venal blood through all the capillary vessels of the lungs.

Both these great or general arteries are subdivided into several branches, and into a great number of ramifications. In this part, we shall describe the distributions of the aorta, leaving the pulmonary artery to the particular history of the lungs. See Part VI.

The basis of the heart being very much inclined to the right side, and turned a little backward, the aorta goes out from it in a direct course, nearly over-against the fourth vertebra of the back. Its course is direct with respect to the heart; but with respect to all the rest of the body, it ascends obliquely from the left to the right hand, and from before backward.

Soon after this, it bends obliquely from the right hand to the left, and from before backward, reaching as high as the second vertebra of the back; from whence it runs down again in the same direction, forming an oblique arch. The middle of this arch is almost opposite to the right side or edge of the superior portion of the sternum, between the cartilaginous extremities or sternal articulations of the first two ribs.

From thence the aorta descends in a direct course along the anterior part of the vertebrae, all the way to the os sacrum, lying a little toward the left hand; and there it terminates in two subordinate or collateral trunks, called arteriæ iliacæ.

The aorta is by anatomists generally divided into the aorta ascendens and aorta descendens, though both are but one and the same trunk. It is termed *ascendens*, from where it leaves the heart to the extremity of the great curvature or arch. The remaining part of this trunk from the arch to the os sacrum or bifurcation, already mentioned, is named *descendens*.

The aorta descendens is further divided into the superior and inferior portions; the first-taking in all that lies above the diaphragm; the other all that lies between the diaphragm and the bifurcation.

The aorta ascendens is chiefly distributed to part of the thorax, to the head and upper extremities. The superior portion of the aorta descendens furnishes the rest of the thorax; the inferior portion furnishes the abdomen and lower extremities.

The great trunk of the aorta, through its whole length, sends off immediately several branches, which are afterwards differently ramified; and these arterial branches may be looked upon as so many trunks with respect to the other ramifications, which again may be considered as small trunks with regard to the ramifications that they send off.

The branches which go out immediately from the trunk of the aorta, may be termed original or capital branches; and of these some are large and others very small.

The large capital branches of the aorta are these: two arteriæ subclaviæ, two carotides, one celiaca, one mesenterica superior, two renales, formerly termed emulgents, one mesenterica inferior, and two iliacæ.

The small capital branches are chiefly the arteriæ coronariæ cordis, bronchiales, œsophagæ, intercostales, diaphragmaticæ inferiores, spermaticæ, lumbares, and sacrales.

These capital branches or arteries are for the most part disposed in pairs; there being none in odd numbers but the celiaca, the two mesentericæ, some of the œsophagæ, the bronchialis, and sometimes the sacra.

The aorta gives rise to two small arteries, called coronariæ cordis, which go to the heart and its auricles; one of which is situated anteriorly, the other posteriorly, and sometimes they are three in number.

From the upper part of the arch or curvature, the aorta sends out commonly three, sometimes four large capital branches, their origins being very near each other. When there are four, the two middle branches are termed arteriæ carotides; the other two, subclaviæ; and both are distinguished into right and left.

When there are but three branches, which is oftentimes the case, the first is a short trunk, common to the right subclavian and carotid, the second is the left subclavian, and the third the left carotid.

The origin of the left subclavian terminates the aorta ascendens.

The carotid arteries run up directly to the head, each of them being first divided into two, one external, the other internal. The external artery goes chiefly to the outer parts of the head and dura mater, or first covering of the brain. The internal enters the cranium, through the bony canal of the os petrosum; and is distributed through the brain by a great number of ramifications.

The subclavian arteries separate laterally, and almost transversely, each toward that side on which it lies, behind and under the claviculæ, from whence they have their name.

The subclavian on each side terminates at the upper edge of the first rib, between the lower insertions of the first scalenus muscle; and there, as it goes out of the thorax, takes the name of arteria axillaris.

During this course of the subclavian artery, several arteries arise from it, viz. the mammaria interna, mediastina, pericardica, diaphragmatica minus five superior, thymica and trachealis.

The thymica and trachealis on each side are, in some subjects, only branches of one small trunk which spring from the common trunk of the right subclavian and carotid.

They are generally small arteries which run sometimes separate, and sometimes partly separate and partly joined.

The subclavian sends off likewise the mammaria interna, vertebrales, cervicales, and sometimes several of the upper intercostales.

The axillary artery, which is only a continuation of the subclavian from where it goes out of the thorax to the axilla, detaches chiefly the mammaria externa, or thoracica superior, thoracica inferior, scapularis externa, scapularis interna, humeralis or muscularis, &c. Afterwards it is continued by different ramifications, and under different names, over the whole arm, all the way to the ends of the fingers.

The superior portion of the aorta descendens gives off the arteriæ bronchiales, which arise sometimes by a small common trunk, sometimes separate, and sometimes do not come immediately from the aorta. It next sends off the œsophagæ, which may be looked upon as mediastinal

posteriores; and then the intercostales from its posterior part, which in some subjects come all from this portion of the aorta, in others only the lowest eight or nine.

The inferior portion of the descending aorta, as it passes through the diaphragm, gives off the diaphragmaticæ inferiores, or phrenicæ; afterwards it sends off several branches, anteriorly, posteriorly, and laterally.

The anterior branches are the cœliaca, which supplies the stomach, liver, spleen, pancreas, &c. the mesenterica superior, which goes chiefly to the mesentery, to the small intestines, and that part of the great intestines which lies on the right side of the abdomen; the mesenterica inferior, which goes to the great intestines on the left side, and produces the hæmorrhoidalis interna; and lastly, the right and left arteriæ spermaticæ.

The posterior branches are the arteriæ lumbares, of which there are several pairs, and the sacrae, which do not always come from the trunk of the aorta.

The lateral branches are the capsulares and adiposæ, the origin of which often varies; the renales, formerly termed emulgents; and the iliacæ, which terminate the aorta by the bifurcation already mentioned.

The iliac artery on each side is commonly divided into the external or anterior, and internal or posterior.

The internal iliaca is likewise named arteria hypogastrica; and its ramifications are distributed to the viscera contained in the pelvis, and to the neighbouring parts, both internal and external.

The iliaca externa, which is the true continuation of the iliac trunk, goes on to the inguen, and then out of the abdomen, under the ligamentum Fallopii; having first detached the epigastrica, which goes to the musculus abdominis recti. Having quitted the abdomen, it commences arteria cruralis, which runs down upon the thigh, and is distributed by many branches and ramifications to all the lower extremity.

We shall now go on to examine particularly all the capital or original branches of the aorta, from their origin, to the entry of them and of their ramifications into all parts of the body.

The CARDIAC or coronary arteries of the heart arise from the aorta immediately on its leaving the heart. They are two in number, and go out near the two sides of the pulmonary artery, which having first surrounded, they afterwards run upon the basis of the heart in form of a kind of crown, or garland, from whence they are called coronariæ; and then pursue the superficial traces of the union of the two ventricles, from the basis of the heart to the apex, and are afterwards lost in the substance of the heart.

The CAROTID arteries are two in number, one called the right carotid, the other the left. They arise near each other, from the curvature of the aorta, the left immediately, the right most commonly from the trunk of the subclavia on the same side.

They run upon each side of the trachea arteria, between it and the internal jugular vein; as high as the larynx, without any ramification. Each of these trunks is afterwards ramified in the following manner.

The trunk having reached as high as the larynx, is

divided into two large branches or particular carotids, one named *external*, the other *internal*, because the first goes chiefly to the external parts of the head, the second enters the cranium, and is distributed to the brain.

The external carotid is anterior, the internal posterior; and the external is even situated more inward, and nearer the larynx, than the other.

The external carotid is the smallest. It runs insensibly outward, between the external angle of the lower jaw, and the parotid gland, which it supplies as it passes. Afterwards it ascends on the fore-side of the ear, and ends in the temples.

In this course it sends off several branches, which may well enough be divided into anterior or internal, and posterior or external; and the principal branches of each kind are these:

The first anterior or internal branch goes out from the very origin of the carotid on the inside; and having presently afterward taken a little turn, and sent off branches to the jugular glands near it, to the fat and skin, it runs transversely, and is distributed to the glandulae thyroideæ, and to the muscles and other parts of the larynx: It likewise sends some branches to the pharynx and muscles of the os hyoides.

The second anterior branch passes over the nearest cornu of the os hyoides, to the muscles of that bone and the tongue, and to the glandulae sublinguales; afterwards passing before the cornu of the os hyoides, it loses itself in the tongue, from whence it has been called *arteria sublingualis*.

The third branch, or arteria maxillaris inferior, goes to the maxillary gland, to the styloid and mastoid muscles, to the parotid and sublingual glands, to the muscles of the pharynx, and to the small flexors of the head.

The fourth branch, arteria maxillaris externa, passes anteriorly on the masseter muscle, and middle of the lower jaw, near the chin. Afterwards it runs under the musculus triangularis labiorum, which it supplies as well as the buccinator and the quadratus menti.

It sends of a particular branch, very much contorted, which divides at the angular commiffure of the lips, and running in the same manner along the superior and inferior portions of the musculus orbicularis, it communicates on both sides with its fellow, and thereby forms a kind of arteria coronaria labiorum.

Afterwards it ascends towards the nares, and is distributed to the muscles, cartilages, and other parts of the nose, sending down some twigs which communicate with the coronary artery of the lips. Lastly, it reaches the great angle of the eye, and is ramified and lost on the musculus orbicularis palpebrarum, superciliaris, and frontalis. Through all this course, it is named arteria angularis.

The fifth branch, maxillaris interna, arises over-against the condyle of the lower jaw. It passes behind the condyle, and having given off a twig among the musculus pterygoidei, it is divided into three principal branches.

The first branch, or sphenomaxillaris, goes through the inferior orbitary, or sphenomaxillary fissure, to the orbit, after having supplied the musculus peritaphalminus; and

and the glandulous membrane of the posterior nares, through the foramen sphenopalatinum.

It is distributed inferiorly and laterally to the parts contained in the orbit, and detaches a small subaltern branch through the extremity of the superior orbicular, or sphenoidal fissure, which enters the cranium, and is spent upon the dura mater.

It sends off likewise another subaltern branch, which passes through the posterior opening of the orbicular canal, and having furnished the maxillary sinus and the teeth, goes out by the inferior orbicular hole, and on the cheek communicates with the angular artery.

The second branch runs through the canal of the lower jaw, and being distributed to the alveoli and teeth, goes out at the hole near the chin, and loses itself in the neighbouring muscles.

The third branch runs up between the internal and external carotids, passes through the foramen spinale of the sphenoidal bone, and is distributed to the dura mater by several ramifications.

The sixth anterior or internal branch, which is very small, is spent on the musculus masseter.

The first external or posterior branch is named arteria occipitalis. It passes obliquely before the internal jugular vein, and having twigs to the musculus stylo-hyoidæus, stylo-glossus, and digastricus, it runs between the styloid and mastoid apophyses, along the mastoid groove, and goes to the muscles and integuments which cover the os occipitis, turning several times in an undulating manner, as it ascends backwards.

The second external branch spreads itself on the outward ear, by a great many small twigs on each side, several of which run inward, and furnish the cartilages, meatus auditorius, skin of the tympanum, and internal ear.

The trunk of the external carotid ascends afterward above the zygoma, passing between the angle of the lower jaw and parotid gland, and forms the temporal artery, which divides into an anterior, middle, and posterior branch.

The anterior branch of the temporal artery goes to the musculus frontalis, communicates with the arteria angularis, and sometimes gives off a very small artery, which pierces the internal apophysis of the os maxillæ all the way to the orbit. The middle branch goes partly to the musculus frontalis, partly to the occipitalis. The posterior branch goes to the occiput, and communicates with the arteria occipitalis. All these branches likewise furnish the integuments.

The internal carotid artery, leaving the general trunk, is at first a little incurvated, appearing as if either it were the only branch of that trunk, or a branch of the trunk of the external carotid.

It is situated a little more backward than the carotis externa, and generally runs up, without any ramification, as high as the lower orifice of the great canal of the apophysis petrosa of the os temporis. It enters this orifice directly from below upward.

At the end of this canal it is again incurvated from below upward, and enters the cranium through a notch of the sphenoidal bone. Then it bends from behind for-

ward, and makes a third angle on the side of the sella sphenoidal; and again a fourth, under the clinoid apophysis of that sella.

As it leaves the bony canal to enter the cranium, it sends off a branch through the sphenoidal fissure to the orbit and eye, and soon afterwards another through the foramen opticum.

Afterwards the internal carotid runs under the basis of the brain, to the side of the infundibulum, where it is at a small distance from the internal carotid of the other side, and there it commonly divides into two principal branches, one anterior, and one posterior.

The anterior branch runs forward under the brain, first separating from that on the other side, then coming nearer again, it unites with it by an anastomosis, or communication, in the interstice between the olfactory nerves. Afterwards having sent off some small arteries, which accompany these nerves, it leaves its fellow, and divides into two or three.

The first of these branches goes to the anterior lobe of the brain; the second, which is sometimes double, is inverted on the corpus callosum, to which it gives some ramifications, as also to the falx of the dura mater, and middle lobe of the brain. The third goes to the posterior lobe of the brain.

The posterior branch communicates first of all with the vertebral artery of the same side, and then divides into several rami, which run between the superficial circumvolutions of the brain, and are ramified in many different directions on and between these circumvolutions, all the way to the bottoms of the sulci.

All these ramifications are covered by the pia mater, in the duplicature of which they are distributed, and form capillary reticular textures in great numbers; and afterwards are lost in the inner substance of the brain.

The SUBCLAVIAN arteries are two in number, one right, the other left; and they arise from the arch of the aorta, on each side of the left carotid, which commonly lies in the middle between them; but when both carotids go out separately, they both lie between the subclavia.

The right subclavian is larger at the beginning than the left, when it produces the right carotid; its origin is likewise more anterior and higher, because of the obliquity of the arch of the aorta. Both of them are distributed much in the same manner, and therefore the description of one, may likewise be applied to the other.

The right subclavian, the longest of the two, gives off, first of all, small arteries to the mediastinum, thymus, pericardium, aspera arteria, &c. which are named mediastinum, thymica, pericardica, and tracheales.

Afterward this right subclavian, at about a finger's breadth from its origin, often produces the common carotid of the same side; and at a small finger's breadth from the carotid, it gives off commonly three considerable branches, viz. the mamma interna, cervicalis, and vertebralis, and sometimes an intercostal artery, which goes to the first ribs, called *intercostalis superior*.

The arteria thymica communicates with the mamma interna, and sometimes arises from the anterior middle part of the common trunk of the subclavian and carotid.

The

The thymus receives likewise some rami from the mammaria interna, and intercostalis superior.

The pericardia arises much in the same manner with the thymica, and runs down upon the pericardium, all the way to the diaphragm, to which it sends some small ramifications.

The mediastina arises sometimes immediately after the thymica, and is distributed principally to the mediastinum.

The trachealis, which may likewise be named *gutturalis inferior*, runs up from the subclavia, in a winding course, along the *aspera arteria*, to the glandulæ thyroideæ and larynx, detaching small arteries to both sides, one of which runs to the upper part of the scapula.

The internal mammary artery comes from the anterior and lower side of the subclavia, near the middle of the clavica, and runs down, for about a finger's breadth, behind the cartilages of the true ribs, an inch distant from the sternum.

In its passage, it sends rami to the thymus, mediastinum, pericardium, pleura, and intercostal muscles. It likewise detaches other branches through these muscles, and between the cartilages of the ribs, to the pectoralis major, and other neighbouring muscular portions; to the mammae, membrana adiposa, and skin.

Afterwards it goes out at the thorax, on one side of the appendix ensiformis, and is lost in the musculus abdominis rectus, a little below its upper part.

The cervical artery arises from the upper side of the subclavian, and is presently afterward divided into two, which come out, sometimes separately, sometimes by a small common trunk. The largest of these two arteries is anterior, the other posterior.

The anterior cervicalis, running behind the carotid of the same side, is distributed to the musculus coraco-hyoideus, mastoideus, cutaneus, sterno-hyoideus, and sterno-thyroideus; to the jugular glands, the *aspera arteria*, the muscles of the pharynx, bronchia, œsophagus; and to the anterior muscles which move the neck and head.

The posterior cervicalis arises sometimes a little after the vertebralis, and sometimes from that artery. It passes under the transverse apophysis of the last vertebra of the neck, and sometimes through a particular hole in that apophysis; and from thence runs up backward in a winding course, on the vertebral muscles of the neck, and then returns in the same manner.

The vertebral artery goes out from the posterior and upper side of the subclavian, almost opposite to the mammaria interna and cervicalis. It runs up through all the holes in the transverse apophyses of the vertebræ of the neck, and, in its passage, sends off little twigs, through the lateral notches of these vertebræ, to the medulla spinalis and its coverings. It also gives arteries to the vertebral muscles, and to other muscles near them.

It sends off a small branch, which is ramified on the outer and posterior parts of the occiput, and communicates with the cervical and occipital arteries. Having afterwards reached the great foramen of the os occipitis, it enters the cranium, and pierces the dura mater.

As soon as it enters the cranium, it sends several small

ramifications to the back-part of the medulla oblongata, and to the corpora olivaria and pyramidalia, which are likewise spread on the back sides of the fourth ventricle of the brain, and form the plexus choroides of the cerebellum.

Afterwards it advances on the apophysis basilaris of the os occipitis, inclining, by small degrees, toward the vertebral artery of the other side, all the way to the extremity of that apophysis, where they both join in one common trunk.

The arteria basilaris runs forward under the great transverse protuberance of the medulla oblongata, to which it gives ramifications, as well as to the neighbouring parts of the medulla.

The spinal arteries are two in number, one anterior, and one posterior; both produced by both vertebrales, each of which, as soon as it enters the cranium, sends out a small branch, by the union of which the posterior spinalis is formed. Afterwards the vertebrales advancing on the apophysis basilaris, or production of the occipital bone, detach backward two other small branches, which likewise meet, and, by their union, form the spinalis anterior. These spinal arteries run down on the fore and back sides of the medulla spinalis, and, by small transverse ramifications, communicate with those which the intercostal and lumbar arteries send to the same part.

The internal auditory artery goes off from each side of the arteria basilaris, to the organ of hearing, accompanying the auditory nerve, having first furnished several small twigs to the membrana arachnoides.

The posterior meningæa arises from the same trunk with the auditoria interna, and goes to the back-part of the dura mater, on the occipital and temporal bones, and supplies the neighbouring lobes of the brain.

When the superior intercostal artery does not go out from the trunk of the aorta descendens, it commonly arises from the lower side of the subclavian, and runs down on the inside of the two, three, or four uppermost true ribs, near their heads, and sends off, under each rib, a branch, which runs along the lower edge, and supplies the intercostal muscles and neighbouring parts of the pleura.

These branches, or particular intercostal arteries, communicate with each other at different distances by small rami, which run upward and downward from one to the other, on the intercostal muscles.

The ductus arteriosus, which is found only in the fœtus and in very young children, arises from the aorta descendens, immediately below the left subclavian artery. In adults, this duct is shrunk up and closed, and appears only like a short ligament adhering by one end to the aorta, and by the other to the pulmonary artery, so that in reality it deserves no other name than that of *ligamentum arteriosum*.

The bronchial arteries go sometimes from the fore-side of the superior descending aorta, sometimes from the first intercostal, and sometimes from the arteria œsophagæa. Sometimes they arise separately from each side, to go to each lung, and sometimes by a small common trunk, which afterwards separates towards the right and left hand, at the bifurcation of the *aspera arteria*, and accompany the ramifications of the bronchia.

The bronchialis gives a small branch to the neighbouring auricle of the heart, which communicates with the arteria coronaria.

The œsophagææ are generally two or three in number, sometimes but one. They arise anteriorly from the aorta descendens, and are distributed to the œsophagus, &c.

The inferior intercostals are commonly seven or eight on each side, and sometimes ten, when the superior intercostals arise likewise from the aorta descendens; in which case these run obliquely upward.

They arise along the back-side of the descending aorta in pairs, all the way to the diaphragm, and run transversely towards each side, on the bodies of the vertebræ. Those on the right side pass behind the vena azygos; and afterwards they all run to the intercostal muscles, along the lower edge of the ribs, all the way to the sternum, or near it.

They send branches to the pleura; to the vertebral muscles, to those muscles which lie on the outsides of the ribs, and to the upper portions of the muscles of the abdomen; and they communicate with the arteriæ epigastricæ and lumbares.

Before they take their course along the ribs, each of them detaches one branch between the transverse apophyses on both sides, to the vertebral muscles, and another which enters the great canal of the spina dorsii.

Afterwards each intercostal artery having reached the middle of the rib, or a little more, divides into two principal branches, one internal, the other external. Soon after this division, the arteries that run upon the false ribs, separate a little from them, being gradually bent downward one after another, and are spread upon the abdominal muscles.

The subclavian artery having left the thorax immediately above the first rib, in the interstice left between the portions of the scalenus, there receives the name of *axillaris*, because it passes under the axilla.

In this course it gives off, from its inside, a small branch to the inside of the first rib; and afterwards four or five principal branches, *viz.* the thoracica superior, or mammaria externa, thoracica inferior, muscularis, or scapularis externa, scapularis interna, and humeralis.

The superior thoracica, or external mammary artery, runs down, in a winding course, on the lateral parts of the thorax, and crosses the ribs. It gives branches to the two pectoral muscles, to the mamma, musculus subclavius, ferratus major, latissimus dorsi, and to the upper portions of the coraco-brachialis and biceps.

The inferior thoracic artery runs along the inferior costa of the scapula, to the musculus subscapularis, teres major and minor, infra-spinatus, latissimus dorsi, ferratus major, and the neighbouring intercostal muscles, communicating with the arteriæ scapulares.

The external scapular artery passes through the notch in the superior costa of the scapula, to the musculus supra-spinatus and infra-spinatus, teres major and minor, and to the articulation of the scapula with the os humeri.

The internal scapularis arises from the axillary artery near the axilla, and runs backward, to be distributed to the subscapularis, giving branches to the ferratus major, to the axillary glands, and to the teres major.

The humeral artery arises from the lower and fore-side of the axillaris, and runs backward between the head of the os humeri and teres major, surrounding the articulation, till it reaches the posterior part of the deltoides, to which it is distributed.

During this course, it gives several branches to the superior portions of the anconæi, to the capsular ligament of the joint of the shoulder, and to the os humeri itself, through several holes immediately below the great tuberosity of the head of that bone.

Opposite to the origin of this humeral artery, the axillaris sends off another small branch, which runs in a contrary direction, between the head of the os humeri, and the common upper part of the biceps and coraco-brachialis; and having given branches to the vagina and channel of the biceps, and to the periosteum, afterwards joins the principal humeralis.

The axillary artery having given off these branches, passes immediately behind the tendon of the pectoralis major, where it changes its former name for that of *arteria brachialis*. It runs down on the inside of the arm, over the musculus coraco-brachialis and anconæus internus, and along the inner edge of the biceps, behind the vena basilica, giving small branches on both sides to the neighbouring muscles, to the periosteum, and to the bone.

Between the axilla and middle of the arm, it is covered only by the skin and fat; but afterwards it is hid under the biceps, and runs obliquely forward as it descends; being at some distance from the internal condyle, but it does not reach the middle of the fold of the arm.

Between the axilla and this place, it sends off many branches to the infra-spinatus, teres major and minor, subscapularis, latissimus dorsi, ferratus major, and other neighbouring muscles, to the common integuments, and even to the nerves. Below the fold of the arm, it divides into two principal branches, one called *arteria cubitalis*, the other *radialis*.

From its upper and inner part, it sends off a particular branch, which runs obliquely downward and backward over the anconæi, and then turns forward again, near the external condyle, where it communicates with a branch of the arteria radialis.

Immediately below the insertion of the teres major, it gives off another branch, which runs from within outwards, and from behind forward, round the os humeri; and descends obliquely forward, between the musculus brachiiæus, and anconæus externus, to both which it is distributed in its passage. Having afterwards reached the external condyle, it unites with the branch last mentioned, and likewise communicates with a branch of the arteries of the fore-arm, so that there is here a triple anastomosis.

About the breadth of a finger below this second branch, the brachial artery sends off a third, which runs down towards the internal condyle, and communicates with other branches of the arteries of the fore-arm, as we shall see hereafter.

About the middle of the arm, or a little lower, much about the place where the brachial artery begins to be covered by the biceps, it sends off a branch, which is distributed

distributed to the periosteum, and penetrates the bone, between the musculus brachizus and anconæus internus.

About an inch lower, it gives off another branch, which having furnished ramifications to the anconæus internus, runs over the inner condyle, and likewise communicates with branches of the arteries of the fore-arm.

Having got below the middle of the arm, the brachial artery detaches another branch, which runs behind the inner condyle, in company with a considerable nerve; and having passed over the muscles inserted in this condyle, it communicates with that branch of the cubital artery which encompasses the fold of the arm.

A little lower, it sometimes sends out another branch, which passes on the fore-side of the inner condyle, and then communicates with a branch which runs up from the cubital artery. These three communicating branches are termed *collateral arteries*.

The common trunk of the brachial artery having reached the fold of the arm, runs, together with a vein and a nerve, immediately under the aponeurosis of the biceps, and passes under the vena mediana, detaching branches on each side to the neighbouring muscles.

About a large finger's breadth beyond the fold of the arm, this artery divides into two principal branches, one inner or posterior, named *cubitalis*; the other outer or anterior, named *radialis*.

From this bifurcation, the brachial artery sends branches on each side, to the supinator longus, pronator teres, fat, and skin. It sometimes, though very rarely, happens, that this artery is divided from its origin into two large branches, which run down on the arm, and afterwards on the fore-arm, where they have the names of *cubitalis* and *radialis*.

The cubital artery sinks in between the ulna and the upper parts of the pronator teres, perforatus, ulnaris gracilis, and radialis internus; then leaving the bone, it runs down between the perforatus and ulnaris internus, all the way to the carpus and great transverse ligament, and sends out several branches.

The first is a small artery, which runs inward to the inner condyle, and then turns upward, like a kind of recurrent, to communicate by several branches with the collateral arteries of the arm, already mentioned, and particularly with the third. A little lower down, another small branch goes off, which having run upward a little way, and almost surrounded the articulation, communicates with the second collateral artery of the arm, between the olecranon and inner condyle.

Afterwards, the cubital artery having, in its course between the heads of the ulna and radius, reached the interosseous ligaments, sends off two principal branches, one internal, the other external, called the interosseous arteries of the fore-arm.

The external artery pierces the ligament about three fingers breadth below the articulation, and presently afterwards gives off a branch, which runs up, like a recurrent, toward the external condyle of the os humeri, under the ulnaris externus and anconæus minimus, to which it is distributed, as also to the supinator brevis.

Afterward, this external interosseous artery runs down on the outside of the ligament, and is distributed to the

ulnaris externus, extensor digitorum communis, and to the extensores pollicis indicis and minimi digiti; communicating with some branches of the internal interosseous artery.

Having reached the lower extremity of the ulna, it unites with a branch of the internal interosseous artery, which, at this place, runs from within outward, and is distributed, together with it, on the convex side of the carpus and back of the hand; communicating with the arteria radialis, and with a branch of the cubitalis.

By these communications, this artery forms a sort of irregular arch, from whence branches are detached to the external interosseous muscles, and to the external lateral parts of the fingers.

The internal interosseous artery runs down very close to the ligament, till it reaches below the pronator teres, between which and the pronator quadratus, it perforates the ligament, and goes to the convex side of the carpus and back of the hand, where it communicates with the external interosseous artery, with the radialis and internal branches of the cubitalis.

From the origin of the two interossee, the cubital artery runs down between the perforatus, perforans, and ulnaris internus, along the ulna, sending branches to the neighbouring parts.

Afterward, it passes over the internal transverse ligament of the carpus, by the side of the os pisiforme, and having furnished the skin, palmaris brevis, and metacarpus, it slips under the aponeurosis palmaris, giving off one branch to the hypothenar minimi digiti, and another, which runs toward the thumb, between the tendons of the flexors of the fingers, and the bases of the metacarpal bones.

It likewise sends off a branch, which, running between the third and fourth bones of the metacarpus, reaches to the back of the hand, where it communicates with the external interosseous artery. Afterwards, having supplied the interosseous muscles, it communicates with the radialis; and they both form an arterial arch, in the hollow of the hand.

This arch sends from its concave side, towards the second phalanx of the thumb, a branch for the lateral internal part thereof, and then ends near the head of the first metacarpal bone, by a communication with the radialis, having first given a branch to the fore-side of the index, and another to the side of the thumb next the former. These communicate, at the ends of the fingers, with the neighbouring branches, as in the other fingers.

This arch sends likewise small twigs to the interosseous muscles, to the lumbricales, palmaris, and to other neighbouring parts; and, lastly, to the integuments.

The radial artery begins by detaching a small branch, which runs upward like a recurrent toward the fold of the arm, and turns backward round the external condyle, communicating with the neighbouring branches from the trunk of the brachial artery.

It runs down along the inside of the radius, between the supinator longus, pronator teres, and the integuments, giving branches to these muscles, and likewise to the perforatus, perforans, and supinator brevis. From thence it runs, in a winding course, towards the extremity of the

the radius, supplying the flexors of the thumb and pronator quadratus.

Having reached the extremity of the radius, it runs nearer the skin, especially toward the anterior edge of the bone, being the artery which we feel there when we examine the pulse.

At the end of the radius, it gives off a branch to the thenar; and, after having communicated with the arch of the cubital artery in the palm of the hand, and let off some cutaneous branches at that place, it detaches one along the whole internal lateral part of the thumb.

Afterwards it runs between the first phalanx and tendons of the thumb, to the interstice between the basis of this first phalanx, and of the first metacarpal bone, where it turns to the hollow of the hand.

At this turning, it sends off a branch to the external lateral part of the thumb, which having reached the end thereof, communicates, by a small arch, with the branch which goes to the internal lateral part.

It likewise sends branches outward, which run between the two first bones of the metacarpus, and the two tendons of the *radialis externus*; and it communicates with an opposite branch of the *cubitalis*, together with which it furnishes the external interosseous muscles and integuments of the back of the hand and convex side of the carpus.

Lastly, the radial artery terminates, in its passage over the semi-interosseous muscle of the index, near the basis of the first metacarpal bone, and as it runs under the tendons of the flexor muscles of the fingers, where it is joined to the arch of the *cubitalis*.

It sends off another branch, which runs along the fore-part of the first bone of the metacarpus, to the convex side of the index, where it is lost in the integuments.

The left **DIAPHRAGMATIC** artery goes out commonly from the aorta descendens, as it passes between the crura of the small muscle of the diaphragm. The right diaphragmatic comes sometimes from the nearest lumbar artery, but most commonly from the *cæliaca*. These arteries likewise have the name of *arteriæ phrenicæ*.

They appear almost always in several ramifications on the concave or lower side of the diaphragm, and seldom on the upper or convex side. They give small branches to the *glandulæ renales*, or *capsulæ atrabiliaria*.

They send likewise small branches to the fat which lies upon the kidneys, from whence they have the name of *arteriæ adiposæ*.

Besides these capital diaphragmatic arteries, there are others of a subordinate class, which come from the *intercostales*, *mammariæ internæ*, *mediastinæ*, *pericardiæ*, and *cæliaca*.

The *cæliac* artery arises anteriorly, and a little to the left hand, from the aorta descendens, immediately after its passage through the small muscle of the diaphragm, nearly opposite to the cartilage, between the last vertebra of the back, and the first of the loins. The trunk of this artery is very short; and near its origin, it sends off from the right side two small *diaphragmaticæ*, though sometimes there is only one, which goes to the right

hand, and is afterwards distributed both ways; communicating with the other arteries of the same name, which come from the *intercostales* and *mammariæ*. The left branch sends rami to the superior orifice of the stomach, and to the *glandula renalis* on the same side; the right furnishes the pylorus, and the renal gland on the right side.

Immediately after this, the *cæliaca* gives off a considerable branch, named *arteria ventriculi coronaria*, and *gastrica*, or *gastricæ superior*; and then it presently divides into two large branches, one toward the right hand, named *arteria hepatica*; the other to the left, called *splénica*.

The coronary artery of the stomach goes first to the left side of that organ, a little beyond the superior orifice; round which orifice it throws branches, and also to every part of the stomach near it; and these branches communicate with those which run along the bottom of the stomach to the pylorus.

Afterwards it runs on the right side of the superior orifice, along the small curvature of the stomach, almost to the pylorus, where it communicates with the *arteria pylorica*; and turning towards the small lobe of the liver, it gives off some branches to it.

Then it advances, under the *ductus venosus*, to the left lobe of the liver, in which it loses itself near the beginning of the duct, having first given off some small branches to the neighbouring parts of the diaphragm and omentum.

As soon as the hepatic artery leaves the *cæliaca*, it runs to the upper and inward part of the pylorus, in company with the *vena portæ*, sending off two branches, a small one called *arteria pylorica*, and a large one named *gastrica dextra*, or *gastrica major*.

The *pylorica* is ramified on the pylorus, and having distributed branches to the neighbouring parts of the stomach, which communicate with those of the right *gastrica*, it terminates on the pylorus, by an anastomosis with the coronary artery of the stomach.

The right *gastric* artery having passed behind and beyond the pylorus, sends out a considerable branch, named *arteria duodenalis*, or *intestinalis*, which sometimes comes from the trunk of the hepatica, as we shall see hereafter. Afterwards this *gastric* artery runs along on the right side of the great curvature of the stomach, to the neighbouring parts of which, on both sides, it distributes branches.

These branches communicate with those of the *arteria pylorica*, and of the *coronaria ventriculi*, and with the right *gastro-epiploicæ*, which furnish the nearest part of the omentum, and communicate with the *mesenterica superior*. After this, the right *gastric* artery ends in the left, which is a branch of the *splénica*.

The duodenal or intestinal artery runs along the duodenum on the side next the pancreas; to both which it furnishes branches, and also to the neighbouring part of the stomach.

The hepatic artery, having sent out the *pylorica* and right *gastrica*, advances behind the *ductus hepaticus*, toward the *vesicula fellis*, to which it gives two principal branches



branches called *arteria cystica*; and another named *bilatoria*, which is lost in the great lobe of the liver.

Afterwards, this artery enters the fissure of the liver, and joins the vena portæ, with which it runs within a membranous vagina, called *capsula Glissoni*, and accompanies it through the whole substance of the liver by numerous ramifications, which may be termed *arteria hepatica propria*.

Before it enters the liver, it gives small branches to the external membrane of this viscus, and to the capsula Glissoni.

Immediately after the origin of the splenic artery from the cæliaca, it runs toward the left hand, under the stomach and pancreas, to the spleen. It adheres closely to the posterior part of the lower side of the pancreas, to which it gives several branches, named *arteria pancreatica*.

Near the extremity of the pancreas, under the left portion of the stomach, the splenic artery gives off a principal branch, called *gastrica sinistra* or *minor*, which runs from left to right along the left portion of the great curvature of the stomach, giving branches to both sides of this portion, which communicate with those of the coronaria-ventriculi.

This gastric artery sends likewise another branch at least to the extremity of the pancreas, which communicates with the other pancreatic arteries. It also supplies the omentum with branches, termed *gastro-epiploica sinistra*; and then it communicates with the right gastric; and from this union, the gastro-epiploicæ mediæ are produced.

Afterwards, the splenic artery advances towards the spleen, in a course more or less contorted; but before it arrives at that viscus, it gives two or three branches to the large extremity of the stomach, commonly called *vasa brevia*; and one to the omentum, named *epiploica*.

At the spleen, this artery divides into four or five branches, which enter that viscus, after having given some small twigs to the neighbouring parts of the stomach and omentum.

The superior mesenteric artery arises anteriorly from the lower portion of the descending aorta, a very little way below the cæliaca, going out a little towards the right hand, but bending immediately afterwards to the left.

Near its origin, it gives off a small branch, which dividing into two, goes to the lower side of the head of the pancreas, and neighbouring part of the duodenum, communicating with the intestinalis by small arches, and areolæ or masses.

Afterwards it passes over the duodenum, between this intestine and the meseraic vein, between the two laminæ of the mesentery; and then bending in an oblique direction from left to right, and from above downward, by very small degrees, it advances toward the extremity of the ileum. By this incurvation, it forms a kind of long arch, from the convex side of which a great many branches go out.

These branches are sixteen or eighteen in number, or thereabouts, and almost all of them are bestowed on the small intestines, from the lower third part of the duodenum to the cæcum and colon.

As they approach the intestines, all these branches communicate, first by reciprocal arches; then by arborescences and masses of all kinds of figures; from which is detached an infinite number of small ramifications, which surround the intestinal canal, like an annular piece of network.

The first branches from the convex side of the mesenteric arch, which are very short, supply the pancreas and mesocolon, and communicate with the duodenal artery. The last branches go to the appendicula vermiformis, and send a portion of an arch to the beginning of the colon.

The considerable branches from the concave side of the mesenteric arch, are seldom above two or three in number; but before they arise, a small ramus goes out to the duodenum, and gives some very small arteries to the pancreas.

The first considerable branch from the concave side of the arch goes into the mesocolon towards the right portion of the colon.

The second principal branch, having run for some space through the mesentery, divides into three rami; the first of which goes to the lower part of the right portion of the colon, the second goes to the beginning of the colon and intestinum cæcum.

The third ramus of the second branch, having communicated with the second, gives small twigs to the cæcum, appendicula vermiformis, and extremity of the ileum.

The lower mesenteric artery goes out anteriorly from the aorta descendens inferior, about a finger's breadth or more above the bifurcation, and below the spermatic arteries; and having run about the length of an inch, or something more, it is divided into three or four branches.

The first or superior branch, about an inch from its origin, divides into two rami; the first of which runs along the left portion of the colon. The second ramus having communicated with the first, runs down upon the same portion of the colon.

The middle branch divides into two rami; one of which passes upward on the extremity of the colon, communicating by arches with the second ramus of the superior branch; the other runs down on the extremity of the same intestine.

The lower branch goes to the second portion of the colon, or to both.

It sends another considerable branch downward, called *arteria hæmorrhoidalis interna*, which runs down behind the intestinum rectum, to which it is distributed by several ramifications.

The renal arteries, commonly called *emulgents*, are ordinarily two in number, and go out laterally from the inferior descending aorta, immediately under the mesenteric superior, one to the right hand, the other to the left.

They run commonly without division, and almost horizontally to the kidneys, into the depressions of which they enter by several branches, which form arches in the inner substance of these viscera.

From these arches, numerous small rami go out toward

ward the circumference or outer surface of the kidneys.

Ordinarily, the right renal artery passes behind the vena cava and renal vein on the other side; and the left artery, first behind and then before the vein.

The arteries of the renal glands, which may be termed *arteriæ capsulares*, arise sometimes from the aorta above the *arteria renalis*, and give out the *arteriæ adiposæ*, which go to the fat of the kidneys. Sometimes they come from the trunk of the *cœliaca*. The right capsular artery comes most commonly from the *arteria renalis* of the same side, near its origin; the left from the aorta, above the *renalis*.

The spermatic arteries are commonly two in number, sometimes more. They are very small, and go out anteriorly from the aorta *descendens inferior*, near each other, about a finger's breadth below the *arteriæ renales*, between the two *mesentericæ*, or between the *renales* and *mesentericæ inferiores*.

They send off to the common membrane of the kidney small branches, named *arteriæ adiposæ*; and afterwards they run down upon the *psoas* muscles, on the fore-side of the ureters, between the two laminae of the peritonæum.

They give several considerable branches to the peritonæum, and communicate both with the *mesentericæ* and *adiposæ*. They likewise send small arteries to the ureters.

Afterwards, they pass in men through the tendinous openings of the abdominal muscles in the vagina of the peritonæum, and are distributed to the testicles and epididymis, where they communicate with a branch of the *iliaca externa*.

In women they do not go out of the abdomen, but are distributed to the ovaria and uterus, and communicate with branches of the *hypogastrica*, at the jagged extremities of the tubæ Fallopianz.

The lumbar arteries go out posteriorly from the inferior descending aorta, in five or six pairs, or more, much in the same manner with the intercostals.

They may be divided into superior and inferior. The superior send small branches to the neighbouring parts of the diaphragm and intercostal muscles, and supply the place of semi-intercostal arteries.

They are distributed on each side to the *psoas* muscles, to the *quadrati lumborum*, and to the oblique and transverse muscles of the abdomen; and by perforating the oblique muscles, they become external *hypogastric* arteries. They go likewise to the vertebral muscles, and to the bodies of the vertebrae, and enter the spinal canal through the lateral notches, to go to the membranes, &c. forming rings much in the same manner with the intercostals.

The *arteriæ sacrae* go out commonly from the back part of the inferior descending aorta, at the bifurcation. They are two, three, or four in number, and sometimes but one. They are ramified on the *os sacrum*, and on the neighbouring parts of the peritonæum, *intestinum rectum*, fat, &c. and enter the canal of that bone through the anterior holes, being there distributed toward each side. They likewise send small arteries to the large fasciculi of nerves, which go out through the holes of the *os sacrum*, and they penetrate the inner substance of that bone.

The inferior descending aorta ends at the last vertebra of the loins, and sometimes higher, in two large lateral branches, one on the right hand, the other on the left, called *arteriæ iliacæ*; each of which is a common trunk to two other arteries of the same name. This bifurcation lies on the anterior and left side of that of the vena cava:

The primitive iliac arteries divaricate gradually as they descend, advancing obliquely toward the anterior and lower part of the *os ilium*, without any considerable ramification for about the breadth of three fingers, except a few very small arteries that go to the *os sacrum*. They likewise give small arteries to the peritonæum, to the coats of the veins, and to the fat and ureters.

The right iliac trunk passes first on the fore-side of the origin of the left iliac vein, and runs down on the fore-side of the right vein, almost to the place where it goes out of the abdomen, its course being there directed more inwardly. The left trunk goes down likewise before the left vein, but lies a little toward the inside as it leaves the abdomen.

About three fingers breadth from their origin, each iliac trunk is divided into two secondary arteries, one external, the other internal. The external artery has no particular name; the internal is termed *hypogastrica*.

The external *iliaca* on each side runs down on the iliac muscle to the ligamentum Fallopii, under which it goes out of the abdomen. In this course, it gives off only a few small arteries to the peritonæum, and other parts near it; but as it passes out of the abdomen under the ligament, it detaches two considerable branches, one internal, the other external.

The internal branch is named *arteria epigastrica*, and goes out anteriorly from the external *iliaca*. From thence it runs obliquely upward on the tendon of the transverse muscle towards the posterior part of the rectus.

Afterwards the epigastric artery runs up along the posterior or inner side of this muscle, sending ramifications to the tendons of the neighbouring muscles, &c. and then loses itself by a true anastomosis of several ramifications, with the *mammaria interna*.

The external branch of the outer *iliaca* goes off laterally from the outside of that artery under the ligamentum Fallopii, and from thence to the internal labium of the *os ilium*, where it divides into two, and is ramified on the oblique and transverse muscles of the abdomen communicating with the *arteria lumbaris*.

Besides these two branches, the external *iliaca* gives off a small ramus internally, under the ligament, which runs to the vagina of the spermatic rope; and sometimes another small twig goes from the outside to the *os ilium*.

The internal *iliaca* or *hypogastrica*, having run a little more than a finger's breadth inward and backward, bends by small degrees obliquely forward, and toward the outside; and afterwards contracting in its dimensions, it ends in the umbilical artery, which ought to be looked upon as a true continuation of the trunk of the *hypogastrica*.

This *arteria umbilicalis* ascends on the side of the bladder, and having detached small rami to that viscus and to the neighbouring parts of the peritonæum, &c. it contracts, and in adults is quite closed up above the middle

middle of the bladder. It likewise gives branches to the uterus, and to the neighbouring parts in both sexes. Afterwards it ascends in form of a ligament to the umbilicus, where it joins the umbilical artery on the other side.

From the convex side of the curvature of the hypogastric artery, four or five principal branches commonly go out very near each other, *viz.* iliaca minor, glutæa, sciatica, pudica communis, five pudica hypogastrica, and obturatrix.

The iliaca minor, the most posterior of these branches, and which is often no more than a ramus of the glutæa, passes between the last two lumbar nerves, and divides into two rami, one of which enters the canal of the os sacrum through the lowest large anterior holes; the other passes behind the musculus psoas, to which it gives twigs, and behind the crural nerve, being afterwards distributed to the iliac muscle, and to the middle part of the inside of the os ilium, penetrating into the substance of the bone sometimes by one hole, sometimes by more.

The arteria glutæa is sometimes the largest of all the hypogastric branches. Near its beginning it sometimes sends out the iliaca minor, and sometimes the small ramus that goes from that artery to the os sacrum and other parts fixed to that bone. Afterwards this artery goes out of the pelvis, in company with the sciatic nerve, through the upper part of the great sinus of the os innominatum, below the musculus pyriformis, and is distributed, in a radiated manner, to the glutæus maximus and medius.

In its passage, it gives some branches to the os sacrum, os coccygis, musculus pyriformis, the muscles of the anus, and to the neighbouring parts of the intestinum rectum, forming a particular hæmorrhoidalis interna. It likewise sends twigs to the bladder and parts near it; and detaches a pretty long branch, which runs down with the sciatic nerve.

The arteria sciatica gives first of all some branches to the musculus pyriformis, the quadrigemi, the os sacrum, &c. and even to the inner side of the os ischium. It likewise detaches a branch, which runs under the musculus quadratus, to the articulation of the os femoris.

The pudica communis, called commonly *pudica interna*, arises sometimes by a trunk common to it and to the glutæa, and gives out two principal branches; the first of which passes through the great sinus of the os ilium, in company with the glutæa and sciatica, and then divides into two rami.

The first ramus goes behind the spine of the ischium, between the two ligaments which lie between that bone and the os sacrum; and runs on the inside of the tuberculum ischii, all the way to the origin of the corpus cavernosum penis. There it divides into several arteries, one of which goes to the sphincter ani, under the name of *hæmorrhoidalis externa*.

The rest are distributed to the neighbouring integuments, to the bulb of the urethra, and to the corpus cavernosum penis; but the last of these arteries, or rather the extremity of this first ramus, runs from behind forward, over the neck of the os femoris, and communicates with a branch of the arteria cruralis.

The second principal ramus, called commonly *arteria pudica externa*, runs between the bladder and intestinum rectum, and is distributed in men to the vesiculæ seminales, neck of the bladder, prostate gland, and neighbouring parts of the rectum.

Afterwards it runs under the os pubis on the side of a considerable vein, which lies directly under the symphysis; and it runs along the penis between this vein and a nerve, being distributed in its passage to the corpus cavernosum, and communicating with the pudica minor, which comes from the cruralis.

This second branch of the pudica major goes off sometimes separately from the hypogastrica, especially in women, being distributed to the lateral parts of the uterus, where it communicates with the spermatic artery, near the jagged extremity of the tuba Fallopiana, and to the neighbouring parts of the vagina, &c.

The arteria obturatrix perforates the obturator muscles, and goes out of the pelvis at the upper part of the ligament of the foramen ovale, having first sent a small branch over the symphysis of the os ilium and os pubis, to the inguinal glands and integuments.

As it passes by the muscles, it divides and is distributed to the pectineus and triceps. It likewise sends out another branch, which communicates with that branch of the sciatica that goes to the articulation of the os femoris; and gives small arteries to the holes in the neck of that bone.

The iliac artery goes out of the abdomen, between the ligamentum Fallopii and tendon of the psoas, at the union of the os ilium and os pubis, and there it takes the name of *arteria cruralis*.

It sends off, first of all, three small branches; one of which, called *pudica externa*, goes over the crural vein to the skin and ligament of the penis, and to the inguinal glands, communicating with the pudica interna. The second goes to the musculus pectineus; and the third to the upper part of the sartorius. All these branches furnish likewise the neighbouring anterior integuments.

Afterwards the crural artery runs down on the head of the os femoris; and, by taking a particular turn, gets on the inside of the crural vein, about three fingers breadth from where it goes out of the abdomen.

In changing its situation, it sends out three considerable branches, one external, one middle, and one internal.

The external branch runs on the upper side of the thigh to the crureus, vastus externus, rectus anterior, musculus fasciæ latæ, and glutæus medius; sending up a ramus to the apex of the great trochanter, which communicates with the first principal ramus of the pudica major and sciatica.

The middle branch runs down on the inside of the thigh between the triceps muscles, to which it gives several rami, one whereof perforates the second muscle, and is distributed to the glutæus maximus, semi-nervosus, semi-membranosus, biceps, and to the neighbouring integuments.

The internal branch runs backward on the quadrigemi, towards the great trochanter; and having detached a ramus, which goes into the joint of the os femoris,

it

it runs downward, and gives rami to all the muscles that lie on the backside of that bone, one of which enters the bone itself on one side of the *linea aspera*.

Having sent off all these three branches, the *arteria cruralis* runs down between the *sartorius*, *vastus internus*, and *triceps*, giving branches to all the parts near it. It is covered by the *sartorius* all the way to the lower part of the thigh, where it is inflected backward over the *triceps tertius* a little above the internal condyle of the *os femoris*. Afterwards, continuing its course through the hollow of the ham, it is called *arteria poplitea*.

The *poplitea*, while in the ham, is covered only by the integument, sending off branches toward each side, which run up upon the condyles, and communicate with the lower ramifications of the *arteria cruralis*.

It sends rami to the joint of the knee, one of which at least passes between the crucial ligaments. As it runs down, it sends branches to the *gastrocnemii* and *popliteus*; and having reached the backside of the head of the tibia, it gives off two branches, one to each side.

The first or internal branch surrounds the fore-part of the head of the tibia, passing between the bone and internal lateral ligament; and besides several other ramifications, sends up a small branch, which communicates with the arteries that lie round the condyles of the *os femoris*.

The second or external branch runs over the head of the fibula, and between the head of the tibia and external lateral ligament of the knee, surrounding the articulation all the way to the ligament of the patella, and communicating with the branches which lie round the condyles of the *os femoris*, together with a branch of the first or internal ramus.

Immediately after the origin of these two rami, and before the *poplitea* ends, it sends a small artery down on the backside of the interosseous ligament, very near the tibia, into which it enters by a particular hole a little above the middle portion of the bone.

As the *poplitea* ends, it divides into two principal branches, one of which runs between the heads of the tibia and fibula, passing from behind forwards on the interosseous ligament, where it takes the name of *arteria tibialis anterior*. The second branch divides into two others; one internal and largest, called *arteria peronæa anterior*; the other posterior and smallest, named *arteria peronæa posterior*.

The *tibialis anterior*, having passed between the heads of the tibia and fibula, sends small branches upward and laterally. The superior branches communicate with those rami of the *popliteus* which lie round the articulation; and the lateral branches go to the neighbouring parts. Afterwards this tibial artery runs down on the fore-side of the interosseous ligament, toward the outside of the tibia, between the *musculus tibialis anticus* and *extensor pollicis*.

Having run laterally on the tibia for about two thirds of the length of that bone, it passes on the fore-side under the common annular ligament, and *extensor pollicis*, to the articulation of the foot; giving off several rami both to the right and left hand, which communicate la-

terally with the *tibialis posterior* and *peronæa posterior*, so that these two bones are in a manner surrounded by arteries.

At the joint of the foot, it sends out branches which run between the *astragalus* and *os calcis*, being distributed to the articulation and to the bones of the tarsus.

Having passed the fold of the foot, it sends off, toward both sides, other rami, which communicate with the posterior *tibialis* and *peronæa*; all these branches making a kind of circles round the tarsus.

Afterwards the anterior tibial artery advances on the convex side of the foot, as far as the interstice between the first and second metatarsal bones; between the heads of which it sends a large branch, which perforates the superior interosseous muscles, and, joining the *tibialis posterior*, forms an arch on the side of the foot.

It likewise sends two or three considerable branches over the other metatarsal bones, which go to the rest of the interosseous muscles, integuments, &c. and communicate with each other.

Lastly, This artery terminates by two principal branches, one of which goes to the thenar and inside of the great toe; the other is spent upon the outside of the great toe, and the inside of the second toe.

The *tibialis posterior*, called likewise *suralis*, runs down between the *solei*, *tibialis posticus*, *flexor digitorum communis*, and *flexor pollicis*; giving branches to these muscles, to the tibia, and to the marrow of that bone, through a particular canal in its posterior and upper part.

Afterwards it runs behind the inner ankle, communicating with the *tibialis anterior*, and surrounded by the neighbouring veins; and passes to the sole of the foot between the concave side of the *os calcis* and *thenar muscle*, where it divides into two branches, one large or external, the other small or internal.

The great branch, or *arteria plantaris externa*, passes on the concave side of the *os calcis* obliquely under the sole of the foot, to the basis of the fifth metatarsal bone, and from thence runs in a kind of arch toward the great toe, communicating there with the *tibialis anterior*, which perforates the interosseous muscles.

The convex side of this arch supplies both sides of the last three toes, and the outside of the second toe, forming small communicating arches as in the hand.

The small branch, or *arteria plantaris interna*, having reached beyond the middle of the sole of the foot, is divided into two; one of which goes to the great toe, communicating with the ramus of the *tibialis anterior*; the other is distributed to the first phalanges of the other toes, communicating with the ramifications from the arch already mentioned.

The *arteria peronæa* runs down on the backside of the fibula, between the *soleus* and *flexor pollicis*, to which, and to the neighbouring parts, it gives rami in its passage.

Having reached to the lower third part of the fibula, it sends off a considerable branch, which runs in between the tibia and that bone, passing between their extremities from behind forward, below the interosseous ligament, and is distributed to the integuments of the tarsus.

Lastly,

Lastly, the peronæa continuing its course downward, on the backside of the fibula, as far as the os calcis, forms an arch with the tibialis posterior, between the astragalus and the tendo-achillis.

From thence it runs outward, and a little above the outer ankle communicates with the tibialis anterior by an arch, which sends several small ramifications to the neighbouring parts.

## P A R T I V.

## O F T H E V E I N S.

**T**HE blood, distributed to all parts of the body by two kinds of arteries, the aorta and arteria pulmonaris, returns by three kinds of veins, called by anatomists *vena cava*, *vena portæ*, and *vena pulmonaris*.

The *vena cava* carries back to the right auricle of the heart, the blood conveyed by the aorta to all parts of the body except what goes by the arteriæ coronariæ cordis. It receives all this blood from the arterial ramifications in part directly, and in part indirectly.

The *vena portæ* receives the blood carried to the floating viscera of the abdomen by the arteria celiaca and the two mesentericæ, and conveys it to the *vena hepatica*, and from thence to the *vena cava*.

The *vena pulmonaris* conveys to the pulmonary sinus, or left auricle of the heart, the blood carried to the lungs by the arteria pulmonaris.

We commonly talk of the *vena cava* in general, as if it were but one vein at its origin, or had but one common trunk; whereas it goes out from the right auricle of the heart by two large separate trunks, in a direction almost perpendicularly opposite to each other, one running upward, called *vena cava superior*; the other downward, called *vena cava inferior*.

The *vena cava superior* is distributed chiefly to the thorax, head, and upper extremities, and but very little to the parts below the diaphragm.

The *vena cava inferior* is distributed chiefly to the abdomen and lower extremities, and but very little to the parts above the diaphragm.

The trunk of each of these two veins sends off, much in the same manner with the arteries, a certain number of principal or capital branches, which are afterwards ramified in different manners. Each trunk terminates afterwards by a bifurcation or a division into two subordinate trunks, each of which gives off other principal branches, ending in a great number of small trunks, rami, and ramifications.

The superior *vena cava* runs up from the right auricle of the heart, almost in a direct course, for about two fingers breadth, lying within the pericardium, in the right side of the trunk of the aorta, but a little more anteriorly.

As it goes out of the pericardium, it is inclined a little to the left hand, and then runs up as high as the cartilage of the first true rib, and a little higher than the

curvature of the aorta. At this place it terminates by a bifurcation or division into two large branches or subordinate trunks, one of which runs toward the left hand, the other toward the right.

These two branches are named *subclaviæ*, as lying behind the clavicle.

The trunk of the superior *cava*, from where it leaves the pericardium to the bifurcation, sends out anteriorly several small branches. These branches are the *vena mediastina*, *pericardica*, *diaphragmatica superior*, *thymica*, *mammaria interna*, and *trachealis*.

All these small branches from the trunk of the *cava superior* are termed *dextræ*; and their fellows on the other side, called *sinistræ*, do not arise from the trunk, but from the left *subclavia*.

Posteriorly, a little above the pericardium, the trunk of the superior *cava* sends out a capital branch, called *vena azygos*, or *vena sine pari*, which runs down on the right side of the bodies of the vertebræ dorsi, almost to the diaphragm; giving off the greatest part of the *venæ intercostales* and *lumbares superiores*.

The two *subclaviæ* run laterally or toward each side, and terminate as they go out of the thorax, between the first rib and clavicle.

The right *subclavian*, which is the shortest of the two, commonly sends out four capital branches; the *jugularis externa*, *jugularis interna*, *vertebralis*, and *axillaris*.

The left *subclavian* being longer than the right, gives off, first of all, the small veins on the left side, answering those on the right side that come from the trunk of the superior *cava*, viz. the *mediastina*, *pericardica*, *diaphragmatica superior*, *thymica*, *mammaria interna*, and *trachealis*.

Next to these small veins, called *sinistræ*, it detaches another small branch, called *intercostalis superior sinistra*, and then four large branches like those from the right *subclavian*, viz. the *jugularis externa*, *jugularis interna*, *vertebralis*, and *axillaris*, which are termed *sinistræ*.

The external jugular veins are distributed chiefly to the outer parts of the throat, neck and head; and send a small vein to the arm, named *cephalica*, which assists in forming a large one of the same name.

The internal jugular veins go to the internal parts of the neck and head, communicating with the sinuses of the

the dura mater, and in several places with the external jugular veins.

The vertebral veins pass through the holes in the transverse apophyses of the vertebræ of the neck, sending branches to the neck and occiput. They form the sinus venales of these vertebræ, and communicate with the sinuses of the dura mater.

The axillary veins are continuations of the subclaviæ, from where these leave the thorax, to the axillæ. They produce the mammariæ internæ, thoraciæ, scapulares or humerales, and a branch to each arm, which, together with that from the external jugularis, forms the vena cephalica.

Afterwards the axillary vein terminates in the principal vein of the arm, called *basilica*; which, together with the cephalica, is distributed by numerous ramifications to all parts of the arm, fore-arm, and hand.

The portion of the inferior vena cava contained in the pericardium is very small, being scarcely the twelfth part of an inch on the fore-part, and not above a quarter of an inch on the back part. From thence it immediately perforates the diaphragm, to which it gives the venæ diaphragmaticæ inferiores or phrenicæ.

It passes next behind the liver, through the great sinus of that viscus, to which it furnishes several branches, termed *venæ hepaticæ*.

In this course it inclines a little toward the spina dorsæ and aorta inferior, the trunk and ramifications of which it afterwards accompanies in the abdomen, all the way to the os sacrum.

Thus the inferior cava sends out on each side, in the same manner with the aorta, the venæ adiposæ, renales, spermaticæ, lumbares, and sacræ. Having reached to the os sacrum, it loses the name of cava, and terminating by a bifurcation, like that of the descending aorta, it forms the two venæ iliacæ.

These iliac veins having given off the hypogastricæ, with all their ramifications, to the viscera of the pelvis, and to some other external and internal neighbouring parts, go out of the abdomen, under the ligamentum Fallopii, and there take the name of *venæ crurales*.

Each crural vein sends off numerous ramifications to all the lower extremity.

The vena azygos or sine pari is very considerable, and arises posteriorly from the superior cava a little above the pericardium.

It is immediately afterwards bent backward over the origin of the right lung, forming an arch which surrounds the great pulmonary vessels on that side.

From thence it runs down on the right side of the vertebræ dorsæ on one side of the aorta, and before the intercostal arteries; and getting behind the diaphragm, it terminates by a very sensible anastomosis, sometimes with the vena renalis, sometimes with a neighbouring lumbar vein, and sometimes immediately with the trunk of the cava inferior.

The vena azygos sends out two or three small veins from the top of the arch, one of which goes to the aspera arteria; the others partly to the aspera arteria, and partly to the bronchia, by the name of venæ

bronchiales, accompanying the ramifications of the bronchial artery.

Afterwards the azygos detaches from the extremity of the arch a small trunk common to two or three small veins, called *intercostales superiores dextræ*, which bring back the blood from the first three series of intercostal muscles, and from the neighbouring part of the pleura.

These intercostal veins send branches through the intercostal muscles to the serratus superior posticus, serratus major, &c. and afterwards they run along the interstices between the ribs, communicating with the venæ mammariæ.

They likewise send small branches backward to the vertebral muscles and canal of the spine, where they communicate with the venal circles, or sinuses which bring back the blood from the medulla spinalis.

As the azygos runs down, it sends off the inferior intercostal veins on the right side, one going to each series of intercostal muscles. These veins run along the lower edges of the ribs, and perforate the muscles by branches, which go to the posterior and external part of the thorax.

They communicate with the venæ thoraciæ, and most commonly with the mammaria interna; and lastly, more or less with each other, by perpendicular branches, near the posterior extremities of the ribs.

The azygos sends off likewise the left intercostal veins, but seldom the whole number; for the superior veins come often from the left subclavian. The inferior intercostal veins, to the number of six or seven, come often from the trunk of the azygos; and running between the aorta and vertebræ, they send off almost the same ramifications with the veins on the right side, and likewise some to the œsophagus.

The azygos, having reached below the last rib, sends off a large branch, which bending outward, perforates the muscles of the abdomen, is ramified between their different planes, and communicates with the like ramifications of the last or last two intercostal veins.

The pectorales internæ, are small veins disposed in pairs toward the right and left hand, behind the sternum and parts near it, including the diaphragmaticæ superiores, or pericardio-diaphragmaticæ, mediastinæ, mammariæ internæ, thymicæ, pericardicæ, and gutturales or tracheales.

The right vena mediastina goes out anteriorly from the trunk of the superior cava, a little above the origin of the azygos; the left comes from the subclavia.

The right superior diaphragmatica, or pericardio-diaphragmatica, comes anteriorly from the root of the bifurcation near the mediastina; and is distributed, by several branches, to the upper, fore, and back parts of the pericardium, communicating with those of the left diaphragmatica. The left superior diaphragmatica comes from the left subclavian, a little below the origin of the mammaria.

The right internal mammaria arises anteriorly from the vena cava, a little below the angle of the bifurcation. It runs along the nearest internal or posterior edge of the sternum, and on the cartilaginous extremities of the

the right ribs, together with the artery of the same name: Having reached near the diaphragm, it sends it a branch which runs toward the tendinous plane, and communicates with the common diaphragmatic veins.

Afterwards this mammary vein gives small branches to the mediastinum, and others between the ribs to the integuments; of which those that pass between and under the cartilages of the last true ribs, run down on the inner or posterior side of the muscoli recti abdominis, being ramified among their fleshy fibres, and communicating with the epigastric veins by several small twigs.

The left internal mammaria arises anteriorly from the left subclavian, opposite to the cartilage or anterior extremity of the first true rib.

The right vena thymica, when it arises separately, goes out from the bifurcation; and when it is wanting, the thymus, from whence it takes its name, is furnished by the gutturalis, or some other neighbouring vein. This vein often reaches no lower than the inferior part of the thymus; and the left vein of the same name comes from the left subclavian, almost opposite to the sternum.

The right pericardia seems to go out rather from the origin of the right subclavian, than from the trunk of the superior cava. It goes to the upper side of the pericardium, and other neighbouring parts.

The right gutturalis or trachealis goes out from the upper part of the bifurcation, above the mammaria of the same side, sometimes more backward, and sometimes from the subclavia. It is distributed to the glandulæ thyroidæ, trachea arteria, muscoli sterno-hyoidæi, thymus, and glandulæ bronchiales. It communicates, by lateral branches, with the internal jugular vein. The left gutturalis comes from the upper or posterior part of the left subclavian, near its origin.

The right subclavian vein is very short, and its course very oblique, so that it appears to rise higher than the left vein. It sends off, first of all, four large branches, viz. the vertebralis, which is the first and most posterior; the jugularis interna, jugularis externa, and axillaris.

The left subclavian seems to ascend but very little after the bifurcation; and, in this course, it covers the origin of three large arteries, which come from the curvature of the aorta. It sends off four large branches, besides the small pectoral veins, and receives the ductus thoracicus.

It likewise gives off, before its principal division, a small trunk for the left superior intercostals, and this intercostal trunk furnishes likewise the left bronchialis.

Each subclavian vein, near the middle of the clavica, sends off a branch, called cephalica, which descends near the surface of the body, between the deltoïdes and pectoralis major.

Each external jugular vein arises from the subclavian on the same side, sometimes from the axillaris, and sometimes from the union of these two veins. They run up between the musculus cutaneus and sterno-mastoidæus.

Sometimes they are double from their very origins; and when they are single, each of them divides afterwards into two, one anterior, and the other posterior, or rather superior. The anterior vein goes to the throat

and face, running up toward the angle of the lower jaw, and the posterior goes to the temples and occiput.

The anterior external jugular vein is often a branch of the jugularis interna, and sometimes it comes from the vena axillaris.

It runs up toward the lateral part of the lower jaw, between the angle and the chin, and sends several branches forwards, backwards, and inwards.

Posteriorly it gives, (1.) A large branch on the side of the upper part of the larynx, which communicates with the jugularis interna, and likewise with a large short branch of the jugularis externa posterior. (2.) A small branch, which has the same communication, but which is not always to be found. (3.) Another small branch a little below the lower jaw, which communicates with the jugularis externa posterior.

Anteriorly it sends several branches to the muscles of the larynx, sterno-hyoidæi, thyro-hyoidæ, and to the integuments; and below the larynx it sends communicating branches to the jugularis externa anterior of the other side.

A little higher, opposite to the cartilago-thyroides, it gives off a transverse branch, which runs on the anterior and lower part of the muscoli sterno-mastoidæi, and communicates with the jugularis of the other side.

The superior and inferior transverse branches communicate on each side by branches more or less perpendicular, and send a small branch to the musculus quadratus of the chin, to the musculus cutaneus and integuments.

It sends another large branch anteriorly toward the symphysis of the lower jaw, which, after having supplied the maxillary glands, is distributed to the digastric muscle, to the chin and under lip.

Interiorly, at the same place, it sends out a large branch, which furnishes the glandulæ sublinguales, runs down toward the cornua of the os hyoides, to communicate with some branches of the jugularis interna, and sends several rami to the tongue, called *venæ raninæ*. It gives off likewise a small branch, which running upon the musculus labiorum triangularis, to the commissure of the lips, is distributed to the neighbouring parts.

The same branch which gives out the *venæ raninæ*, detaches another to the lateral parts of the septum palati, which is distributed to the amygdalæ, and to the uvula, and sends rami forward to the membrane which lines the arch of the palate. Another branch goes out from it to the pterygoideus internus, peristaphylini, and cephalopharyngæi.

Afterwards the trunk of the anterior external jugular vein runs up on the musculus triangularis, where it receives the name of vena triangularis, in a winding course from the angle of the lower jaw to the great or internal angle of the orbit, sending branches on each side to the muscles and integuments.

The trunk of the vena angularis having reached the bones of the nose, sends out a branch through the lateral cartilages of the nose, which is distributed to the nares; and another which runs down in a winding course to the upper lip.

At the great or inner angle of the eye, the same trunk sends off several other branches; the first of which goes

to the root of the nose, and communicating with its fellow from the other side, gives several small veins to the holes of the ossa nasi.

The second branch runs up on the fore-head, by the name of *vena frontalis*, and is distributed to each side.

The third branch enters the orbit in a winding course, on one side of the cartilaginous pulley, and communicates with the sinuses of the dura mater, by the orbitary sinus of the eye.

The fourth branch goes along the musculus superciliaris and the upper part of the orbicularis, to the small or external angle of the eye, to communicate with the vena temporalis, and with that vein which runs along the lower part of the orbicular muscle.

The posterior or superior external jugular vein runs up toward the parotid gland, and lower anterior part of the eye, giving out several branches toward each side.

At its origin it sends out posteriorly, a principal branch, with its ramifications, to the muscles which cover the scapula and joint of the humerus, commonly called *vena muscularis*.

A little higher, it gives off the vena cervicalis, which goes to the vertebral muscles of the neck.

Near the cervical vein, but a little more outward, it gives off sometimes the small vena cephalica, which runs down between the pectoralis major and deltoides, and unites with the vena cephalica of the arm.

Backward it detaches the vena occipitalis, which is distributed on the occiput; it likewise sends out a small vein, which enters the cranium by the posterior mastoid hole, and terminates in one of the lateral sinuses of the dura mater.

Having reached as far as the parotid gland, it forms communications with the anterior external jugular, under the angle of the lower jaw; and then passes through the parotid gland, between that angle and the condyle, giving off a large branch which communicates with another branch common to the internal and anterior external jugulars.

Afterwards it passes before the ear, taking the name of *vena temporalis*, which is distributed to the temples and lateral parts of the head, towards the occiput and forehead.

The temporal vein of one side communicates, above, with its fellow on the other side; before, with the vena frontalis; and behind, with the vena occipitalis. Opposite to the ear, it gives out a large branch, one ramus of which runs under the lower edge of the zygoma, and then returning, communicates with another ramus from the same jugularis, a little below the condyle of the lower jaw.

Behind this condyle, it gives branches to the temporal muscle, to the neighbouring parts of the upper jaw, and to the inside of the lower jaw.

The internal jugular vein is the largest of those that go to the head.

It runs up behind the sternomastoidæus and omo-hyoidæus, which it crosses, along the sides of the vertebræ of the neck, by the edge of the longus colli, to the fossula of the foramen lacerum of the basis cranii.

The first branches which it sends off are small, and go

to the thyroid glands. About two fingers breadth higher up, it detaches a middle-sized branch, which runs laterally towards the larynx, and may be named *vena gutturalis*.

This guttural vein divides chiefly into three branches; the lowest of which goes to the thyroid gland and neighbouring muscles; the middle branch to the larynx, musculi thyroidæi, &c. and the third runs upward to the great communication between the two jugulars.

About the same distance upward, almost opposite to the os hyoides, the internal jugular gives another branch, which sends rami to the muscles belonging to that bone, and others which communicate with the foregoing branch. This other branch runs upward toward the parotid gland and angle of the lower jaw, where it sends communicating branches forward and backward to the two external jugulars.

The internal jugular sends another branch backward, which is distributed to the occiput, where it communicates with a branch of the vertebralis, and, through the posterior mastoid hole, with the lateral sinus of the dura mater.

Afterwards it reaches the foramen lacerum of the basis cranii, bending a little, and sending off small twigs to the pharynx and neighbouring muscles.

The vertebral vein arises posteriorly from the subclavia or axillaris, sometimes by two stems.

The first and principal stem gives out a branch, called *vena cervicalis*, which is distributed to the neighbouring muscles, and afterwards runs up through the holes of the transverse apophyses of the vertebræ colli.

The other stem of the vertebral vein runs up on the side of the vertebræ; and having reached the fourth, or sometimes higher, it runs in between the transverse apophyses of that vertebra and the fifth, to join the first or principal stem.

Thus the vertebral vein accompanies the artery of the same name, sometimes in one trunk, sometimes in several stems, through all the holes of the transverse apophyses of the vertebræ colli, all the way to the great foramen occipitale, communicating with the occipital veins and small occipital sinuses of the dura mater.

In its passage it gives off one branch, which enters by the posterior condyloid hole of the os occipitis, and communicates with the lateral sinus of the dura mater.

As these veins run through the holes in the transverse apophyses, they send branches forward to the anterior muscles of the neck, and to the small anterior muscles of the head.

Other branches go likewise outward and backward to the musculi transversales and vertebrales colli; and inward to the great canal of the spinal marrow, where they form sinuses, which communicate with those on the other side.

These vertebral sinuses are pretty numerous, and placed one above another all the way to the occiput; the lower communicate with the upper; and at the great foramen of the os occipitis there is a communication between them and the occipital sinuses of the dura mater.

The subclavian vein having sent off the branches already described, goes out of the thorax, and passes before

fore



fore the anterior portion of the musculus scalenus, and between the first rib and the clavicle, to the axilla. Through this course it takes the name of *vena axillaris*, and gives off several branches, the chief of which are the *venæ musculares*, *thoracicæ*, and *vena cephalica*.

The musculares, are distributed to the middle portion of the musculus trapezius, to the angularis, infra-spinatus, and subscapularis; and as some of these branches go to the shoulder exteriorly, others interiorly, the *venæ scapulares* are distinguished into external and internal.

A little before the axillaris reaches the axilla, it sends out the *venæ thoracicæ*, one of which is superior, called also *mammaria externa*, and the other inferior. It likewise sends rami to the musculus subscapularis, teres major, teres minor, supra-spinatus, latissimus dorsi, serratus major, pectoralis minor, pectoralis major, and to the glands of the axilla.

The axillaris having reached the side of the head of the os humeri, produces a branch, named *vena cephalica*, and afterwards runs along the arm by the name of *vena basilica*.

The cephalic vein, which is a branch of the axillaris, at a small distance from its origin, joins the small cephalica, which runs down from the subclavia, or jugularis externa.

The great cephalica runs down between the tendons of the last mentioned muscles, and along the outer edge of the external portion of the biceps; communicating several times with the vena basilica, and sending small rami on each side, to the neighbouring muscles, fat and skin.

A little below the external condyle of the os humeri, it detaches a branch backward, which runs up between the musculus brachialis and the upper portion of the supinator longus, and afterwards bends back between the os humeri and anconæus externus, where it communicates with some branches of the basilica.

Having reached very near the fold of the arm, it is divided into two principal branches, one long, the other short. The long branch is named *radialis externa*, and the short one may be called *mediana cephalica*, to distinguish it from another mediana, which is a short branch of the basilica.

The external radial vein runs along the radius between the muscles and integuments, giving off branches towards both sides, which communicate with other branches of the same vein, and with some from the basilica.

The mediana cephalica runs down obliquely toward the middle of the fold of the arm, under the integuments, and over the tendon of the biceps, where it joins a short branch of the same kind from the basilica.

From this anastomosis, a considerable branch goes out, which runs down on the fore-arm, uniting on one side with the vena cephalica, and communicating on the other with the basilica, by several irregular areolæ. The name of *mediana* is given to this large branch, as well as to the two short ones, by the union of which it is formed.

From this union of the two lateral medianæ, and sometimes from the origin of the mediana media, a branch goes out, which runs down on the inside of the

fore-arm, opposite to the interosseous ligament, and is called *vena cubiti profunda*. It goes to the neighbouring muscles, and communicates with the other veins of the fore-arm. The mediana cephalica sometimes sends down a long branch, called *radialis interna*, which lies almost parallel to the radialis externa.

Afterwards the cephalica, having reached the extremity of the radius, is distributed, by numerous areolæ, almost in the same course with the radial artery.

A particular branch goes out from it, which runs more or less superficially between the thumb and metacarpus, by the name of *cephalica pollicis*. The areolæ furnish the interosseous muscles and integuments, and communicate with a small ramus from the basilica, called by the ancients *Salvatella*.

The basilic vein sends off first of all, under the head of the os humeri, a pretty large branch, which passes almost transversely round the neck of that bone, from within backward, and from behind outward, running upon the scapula, where it is ramified on the deltoides, and communicates with the *venæ scapulares externæ*. This branch may be named *vena sub-humeralis*, or articularis.

This articular vein sends down two principal branches, one of which runs along the inside of the bone, to which, and to the periosteum, it gives small veins. The other turns forward, toward the middle of the arm between the bone and the biceps, and communicates with the cephalica.

Below the neck of the os humeri, near the hollow of the axilla, and behind the tendon of the pectoralis major, the basilica sends out a considerable branch, which runs down on the side of the brachial artery, and furnishes the neighbouring muscles on both sides. This vein is named *profunda brachii*.

Immediately afterwards, the basilica detaches two or three small veins, which run down very closely joined to the brachial artery, surrounding it at different distances by small twigs which communicate with each other.

These small veins, which often arise from the profunda superior, communicate with the basilica and cephalica; and having reached the fold of the arm, they divide like the artery; and the same divisions are continued along the whole fore-arm.

Afterwards the basilica continues its course along the inside of the os humeri, between the muscles and integuments, forming many communications with the vena profunda and cephalica, and supplying the muscles and integuments.

Having reached the inner condyle, and having sent off obliquely, in the fold of the arm, the mediana basilica, it runs along the ulna, between the integuments and muscles, a little toward the outside, by the name of *cubitalis externa*.

The basilica having at length reached the extremity of the ulna, sends several branches to the convex side of the carpus; one of which, named *Salvatella*, goes to that side of the little finger next the ring finger, having first communicated with the cephalica, by means of the venal areolæ conspicuous on the back of the hand. In the other fingers this vein follows nearly the same course with the arteries.

In general, the external or superficial veins of the forearm are larger than the internal.

The inferior *VENA CAVA* having run down about a quarter of an inch from the right auricle of the heart, within the pericardium, pierces that membrane and the tendinous portion of the diaphragm.

At this place it gives off the *venæ diaphragmaticæ*, or *phrenicæ*, which are distributed to the diaphragm, and appear chiefly on its lower side, one towards the right hand, and one towards the left. The right vein is more backward and lower than the left. The left is distributed partly to the pericardium, and partly to the diaphragm; and sometimes they send rami to the *capsulæ renales*.

The inferior cava having perforated the diaphragm, passes through the posterior part of the great fissure of the liver, penetrating a little into the substance of that viscus, between the great lobe and the lobulus Spigelii.

In its passage, it sends off commonly three large branches, called *venæ hepaticæ*, which are ramified in the liver.

Besides these large branches, it sends out some other small ones, either before or immediately after it goes out of the liver.

In the fœtus, as the vena cava passes by the liver, it gives off the *ductus venosus*, which communicates with the sinus of the vena portæ; and in adults is changed to a flat ligament.

After its passage through the liver, the vena cava turns from before backward, and from right to left, toward the *spina dorsi*, placing itself on the right side of the aorta, which it accompanies from thence downward.

Having got as low as the *arteriæ renales*, it gives off the veins of the same name, termed formerly *venæ e-surgentes*.

The right renal runs down a little obliquely, because of the situation of the kidney. The left vein crosses on the fore-side of the trunk of the aorta, immediately above the superior mesenteric artery.

They send up the *venæ capsulares*, which go to the *glandulæ renales*, and downward; the *venæ adiposæ*, which go to the fatty covering of the kidneys; and ordinarily the left renal vein furnishes the left spermatic vein. Afterwards they run to the sinus, or cavity of the kidneys, in the substance of which they are distributed by numerous ramifications.

A little below the renal veins, the trunk of the cava sends out anteriorly, toward the right side, the right *vena spermatica*. The left spermatic vein comes commonly from the left renal.

In their passage, they send several small branches on each side, to the peritoneum and mesentery, where they seem to be joined by anastomoses with the *venæ mesentericæ*.

The cava sends likewise off posteriorly the *venæ lumbares*, which commonly arise in pairs. These may be divided into superior and inferior veins.

Their origins vary in different manners. Sometimes the cava gives off a branch to each side below the first vertebra of the loins, which, like a common trunk, furnishes the lumbar veins. This branch communicates with the *azygos*.

Sometimes a considerable branch goes out from the lower extremity of the cava, near the bifurcation, chiefly on the right side, which afterwards running up between the bodies and transverse apophyses of the vertebræ, detaches the *venæ lumbares*, and communicates with the *azygos*.

Sometimes a like branch comes from the beginning of the left vena iliaca, and, running up on that side in the same manner, produces the *lumbares*.

The *venæ lumbares* on one side communicate by transverse branches with those of the other side, and likewise with each other by branches more or less longitudinal. The first and second often go from the *azygos*, and thereby they communicate with the intercostal veins.

The lumbar veins send small capillaries, in their passage, to the substance of the bodies of the vertebræ; and they are distributed to the muscles of the abdomen, *quadratus lumborum*, *psoas*, *iliacus*, &c. They send branches backward to the neighbouring vertebral muscles, and to the canal of the spine, and communicate with the venal sinuses.

The inferior cava, having reached as low as the last vertebra of the loins, and near the bifurcation of the aorta, runs in behind the right iliac artery, and there is divided into two subaltern trunks, called the *right and left iliac veins*.

From this bifurcation of the vena cava, the *vena sacra* goes out, and accompanies the artery of the same name in its distribution to the os sacrum, to the nerves which lie there, and to the membranes which cover both sides of that bone.

Each original iliac vein is divided on the side of the os sacrum, much after the same manner as the arteries, into two large trunks.

One of these trunks is named *vena iliaca externa* or *anterior*; the other *interna* or *posterior*.

These veins follow nearly the course and distribution of the iliac arteries, except that the hypogastric vein does not send off the *vena umbilicalis*.

From the common trunk of the iliac veins, and sometimes from the origin of the *iliaca externa*, a particular branch goes out, which is distributed to the *musculus psoas*, *iliacus*, and *quadratus lumborum*; and afterwards sends a ramus on the fore-side of the last transverse apophysis of the loins, to communicate with the last lumbar vein.

The external iliac, a little before it leaves the abdomen, near the ligamentum Fallopii, lying on the *psoas* and *iliac* muscles, gives off almost the same branches with the artery of the same name, and follows the same course. The chief branches are these:

A little before it goes out of the abdomen, it sends off from the outside, a small branch, which runs up along the crista of the os ilium, and gives branches on each side to the lateral and posterior lower portions of the *musculi abdominis*, to the *musculus iliacus*, &c.

From the inside, before it leaves the abdomen, it sends off the *vena epigastrica*; which having furnished some small rami to the neighbouring conglobated glands, runs up along the inside of the *musculi recti*, on which it is ramified both ways.

Afterwards

Afterwards the *vena epigastrica* runs upward, and joins the ramifications of the *mammæria*.

Before the iliac vein gets from under the *ligamentum Fallopii*, it sends several small rami to the neighbouring lymphatic glands; and immediately afterwards, losing the name of *iliaca*, it takes that of *cruralis*.

The hypogastric, or internal iliac vein, runs behind the iliac artery, from which the following branches go out.

From the posterior or convex part of the arch, it gives a branch to the superior lateral part of the *os sacrum*, which is distributed to the *musculus sacæ*, or *transversospinalis lumborum*, and other muscles thereabouts, and to the cavity of the bone, which it enters through the first great hole.

A little lower, on the same side, it sends out another, which is distributed much in the same manner with the former; and enters the second hole.

From the external lateral part of the same arch, a little anteriorly, it sends out a large branch, which runs behind the great sciatic sinus, and is distributed to the *musculi glutæi*, *pyriformis*, and *gemelli*.

Lower down, the same lateral part of the hypogastric vein gives out another large branch, called *obturatrix*; which, having run a little way, detaches several rami, and afterwards reaching the *foramen ovale* of the *os indominatum*, perforates the obturator muscles, communicates with the *vena cruralis*, and is distributed to the *musculus pectineus*, *triceps*, and neighbouring parts.

Among the branches sent off by the *vena obturatrix*, before it perforates the muscles, one is situated exteriorly, which runs toward the sciatic sinus, to the *musculus iliacus*, the superior part of the *obturator internus*, and to the *os ilium*.

Interiorly, the same obturator vein sends off another branch, which is distributed to the ureters, bladder, and internal parts of generation in both sexes.

Lastly, the hypogastric vein runs backward, and goes out of the pelvis, above the ligament which lies between the inferior lateral part of the *os sacrum* and spine of the *ischium*.

It next sends a large branch upward to the lower part of the *os sacrum*, and two or more downward; which, running behind the same ligament, are distributed to the buttocks, anus, neighbouring portion of the *musculus pectineus*, and to the external parts of generation.

The veins that go to the anus, are termed *hæmorrhoidales externæ*; they that go to the parts of generation, *pudicæ internæ*. The external hæmorrhoidales communicate with the internal veins of the same name, which come from the small *vena mesaraica*.

The crural vein goes out under the *ligamentum Fallopii*, on the inside of the crural artery, and immediately gives small branches to the inguinal glands, the *musculus pectineus*, and parts of generation. These last are termed *pudicæ externæ*, and evidently communicate with the internal veins of the same name.

About an inch below, where it leaves the abdomen, the crural vein produces a large branch, which runs down anteriorly between the integuments and the *farto-*

*rius*, following the direction of that muscle almost all the way to the inside of the thigh.

This branch having afterwards got beyond the condyles of the *os femoris*, runs down between the integuments and inner angle of the tibia, to the fore-part of the inner ankle, and is distributed to the foot. All this large branch is named *vena saphena*, or *saphena major*.

After the origin of the *saphena*, as the trunk of the crural veins runs down, it sinks in between the muscles, and is distributed to all the inner or deep parts of the lower extremity, accompanying the crural artery to the very extremity of the foot.

As the *saphena* is a vein of very large extent, we shall here describe it altogether, and afterwards return to the *vena cruralis*.

The *vena saphena*, in its passage from the inguen to the foot, is covered only by the skin and fat. Immediately after its rise, it gives small veins to the inferior inguinal glands; and then it gives out others more anteriorly, which, running under the integuments, communicate with each other by numerous *arcolæ*.

The *saphena*, having run down on the thigh, as low as the middle of the *sartorius*, sends off to the same side several branches, which communicate with each other, and with the superior branches.

Between these upper and lower branches, the *saphena* sends backward a particular branch; which, after being distributed to the integuments which cover the *gracilis internus* and *triceps*, turns backward; and a little below the ham, runs in among the muscles situated there, and communicates with another branch, which may be termed *saphena minor*.

Afterwards the trunk of the great *saphena* runs down on the inside of the tibia, lying always near the skin; and at the upper part of that bone it sends branches forward, outward, and backward.

The anterior branches go to the integuments on the upper part of the leg; the posterior, to those which cover the *gastrocnemii*, and communicate with the little *saphena*; and the external branches are likewise distributed to the fat and integuments, and having reached as low as the middle of the tibia, it sends a communicating branch to the trunk of the great *saphena*.

From this communication, a branch goes out anteriorly, which runs along the integuments of the tibia all the way to the outer ankle.

As the *saphena* runs down on the inside of the tibia, it sends out a branch near the middle of that bone, which runs up behind the tendons of the *sartorius*, *gracilis internus*, and *femio-nervosus*, then between the tibia and upper end of the *soleus*, and is joined by an anastomosis with the crural vein.

At the lower part of the tibia, the *saphena* produces a considerable branch, which runs obliquely forward over the joint of the tarsus toward the outer ankle, sending off several rami which communicate with each other, and with the trunk of the *saphena*.

The extremity of this trunk passes on the fore-side of the inner ankle, and runs irregularly under the skin, a-

long,

beg the interstice between the first two metatarsal bones toward the great toe, where this vein terminates.

The crural vein, having sent off the saphena, and the small branches for the pectineus, &c. as has been said, runs down on the thigh behind the crural artery. Opposite to the little trochanter, it produces two large short branches, or one which afterwards divides into two, whereof one is anterior, the other posterior.

The anterior branch runs more or less transversely forward, to be distributed to the vastus internus, lower part of the pectineus, and of the second triceps, and to the other two muscles of the same name, running in between them as it goes from one to another.

The posterior branch runs more or less transversely backward, and furnishes the glutæi, vastus externus, and beginning of the biceps.

A little below these two branches, about the upper extremity of the vastus internus, the crural vein produces a branch which runs down on the side of the trunk, covering the crural artery, almost as low as the ham, where it is again united to the trunk by an anastomosis. It has the name of *vena sciatica*, from the sciatic nerve which it accompanies.

On the outside of this anastomosis, the crural vein gives off a branch which runs backward between the biceps and neighbouring muscles, and so downward on the backside of the leg a little exteriorly, and very near the skin, all the way to the outer ankle. This vein is termed *saphena minor*, or *externa*.

The little saphena, having got near the integuments in its course downward, gives out a branch which runs backward, and communicates with the great saphena about the middle of the backside of the thigh.

Immediately above and below the ham, this vein sends out other branches, which likewise communicate with the saphena major, and, having run down about one third part of the backside of the tibia, it sends off another branch, which is afterwards re-united to the trunk.

About the beginning of the tendo-achillis, the little saphena runs outward in the integuments, toward the outer ankles, where it terminates in cutaneous ramifications sent to every side.

The crural vein, having detached the little saphena, runs down between the biceps and the other flexors of the leg, closely accompanied by the crural artery, between which and the inner condyle of the os femoris it is situated.

A little above the ham, it takes the name of *vena poplitea*; and as it runs down betwixt the two condyles, it gives branches to the flexor muscles, to the lower and posterior parts of both vasti, and to the fat which lies above the interstices of the two condyles.

It likewise gives off several other branches, one of which runs up laterally between the outer condyle and the biceps, and then turning forward, is ramified in the same manner with the artery.

The *vena poplitea* runs down immediately behind the muscle of the same name, at the lower part of which it sends off several ramifications to each side, which divide and unite again in different ways; and afterwards it loses its name, being divided into three considerable

branches, called *tibialis anterior*, *tibialis posterior*, and *peronæa*.

The anterior tibial vein, having distributed some small branches from its very beginning to the muscles behind the heads of the two bones of the leg, perforates the interosseous ligament from behind, forward, and runs between the superior portions of the musculus tibialis anticus, and extensor digitorum communis.

As soon as it pierces the interosseous ligament, it distributes small superficial branches to the head of the tibia and fibula, which run to the joint of the knee, and communicate with the lateral branches of the *vena poplitea*.

Afterwards it divides into two or three branches, which run down together on the fore-side of the interosseous ligament in company with the anterior tibial artery, which they surround at different distances, by small communicating circles.

These branches having reached the lower extremity of the leg, unite in one, which afterwards divides into several, the ramifications of which are distributed to the foot.

The posterior tibial vein gives off, from its beginning, a branch toward the inside, which is distributed to the gastrocnemii and soleus. This vein is named *suralis*.

Afterwards the posterior tibialis runs down between the soleus and tibialis posticus, giving branches to each of them. It is divided in the same manner as the tibialis anterior, into two or three branches, which, as they run, surround the corresponding artery, by small communicating circles formed at different distances.

It continues this course in company with the artery as low as the outer ankle, furnishing the musculus tibialis posticus, and the long flexors of the toes.

Lastly, it passes on the inside of the os calcis, under the sole of the foot, where it forms the *venæ plantaræ*, by dividing into several transverse arches, which communicate with each other, and with the saphena, and send ramifications to the toes.

The *vena peronæa* is likewise double, and sometimes triple. It runs down on the inside of the fibula, which it likewise surrounds at different distances, by communicating branches, after the manner of the tibialis posterior.

It runs down as low as the outer ankle, communicating several times with the tibialis posterior, and sending ramifications to the neighbouring portions of the musculi peronæi, and long flexors of the toes.

The *vena portæ* is a large vein, the trunk of which is situated chiefly between the eminencies on the lower or concave side of the liver.

It may be considered as made up of two large veins, joined almost endwise by their trunks, from each of which the branches and ramifications go out in opposite directions. One of these trunks adheres to the liver, and is ramified in that viscus, its branches accompanying the whole distribution of the hepatic artery.

The other trunk is without the liver, and sends its branches to the viscera, supplied by the rest of the *arteria cæliaca*, and by the two mesentericæ, that is, to the stomach, intestines, pancreas, spleen, mesentery, and omentum.

The first portion of this vein may be termed *vena porta*

*porta hepatica, superior or minor*, the trunk of which is commonly known by the name of *sinus vena portarum*. The other portion may be called *vena porta ventralis, inferior or major*.

The large trunk of the vena portæ inferior, or ventralis, is situated under the lower or concave side of the liver, and joined by an anastomosis to the sinus of the vena portæ hepatica, between the middle and right extremity of that sinus. From thence it runs down a little obliquely from right to left, behind or under the trunk of the arteria hepatica, bending behind the beginning of the duodenum, and under the head of the pancreas.

Having reached to the head of the pancreas, this trunk loses the general name of *vena portæ*, and terminates in three large principal branches, which are distributed, by numerous ramifications, to the viscera already named. The first branch is termed *vena mesaraica, or mesaraica major*; the second, *splénica*; and the third, *hæmorrhoidalis-interna, or mesaraica minor*.

The vena mesaraica major appears to be a continuation of the trunk of the vena portæ inferior. The splénica is a capital branch of that trunk; and the hæmorrhoidalis interna has sometimes a common origin with the splénica.

The inferior vena portæ, before the formation of these three branches, sends off from the trunk several small rami, which are commonly the venæ cysticæ, hepatica minor, pylorica, duodenalis, and sometimes the galtrica recta, and coronaria ventriculi.

All these small veins sometimes arise separately; and, in other subjects, some of them go out by small common trunks.

The cystic veins run along the vesicula fellis, from its neck to the bottom; and as they are often no more than two in number, they are called *cysticæ gemellæ*.

The small hepatic vein is commonly a branch of one of the cysticæ.

The vena pylorica arises from the great trunk, almost opposite to the origin of the cysticæ; and sometimes is only a branch of the right galtrica. It passes over the pylorus to the short arch of the stomach, where it is joined, by anastomosis, with the coronaria ventriculi.

The duodenal vein, commonly called *vena intestinalis*, goes out from the great trunk near the cysticæ, and sometimes from the small common trunk of these veins. It is distributed chiefly to the intestinum duodenum, and sends likewise some rami to the pancreas.

The inferior vena portæ, having given off the splénica, changes its name to that of *mesaraica, or mesaraica major*; which often appears to be rather a continuation of the trunk, than of one of the great branches.

It bends toward the superior mesenteric artery, sending off two veins, and afterwards running up over that artery, it accompanies it in those portions of the mesentery and mesocolon which belong to the small intestines, the cæcum, and right portion of the colon.

The first particular branch from this trunk is called *vena colica*. It goes out from the anterior part of the trunk, before it joins the artery, and runs directly to the middle of the colon, where it divides to the right and left, and forms arches. On the left hand, it communicates

with the superior or ascending branch of the hæmorrhoidalis; and on the right, with the second branch of the mesaraica.

This second branch is a little under the first, or colica anterior, and something more towards the right hand. It may be named *gastro-colica*, and is soon divided into two branches, one superior, the other inferior.

The superior branch of the vena gastro-colica sends small veins to the head of the pancreas, and forms the vena galtrica, or gastro-epiploica dextra, which goes from the pylorus to the great curvature of the stomach, and communicates with the galtrica sinistra. In its passage it supplies the stomach and omentum, and communicates with the pylorica, coronaria ventriculi, &c.

The inferior branch of the vena gastro-colica, which may be called *colica dextra*, goes to the right portion of the colon; and from thence to the upper part of that intestine, where it is divided archwise, and communicates with the right branch of the colica anterior, and with a branch of the vena cæcalis.

The trunk of the great mesaraic vein sends out sometimes, opposite to the galtrica, a particular branch to the omentum, called *epiploica dextra*. But almost immediately before it ascends over the mesenteric artery, it produces two large branches very near each other, which pass behind and under the artery, being distributed to the jejunum and part of the ilium by numerous ramifications.

Afterwards the trunk of the mesaraic passes over the superior mesenteric artery, to which it adheres very closely, and from the convex side of its arch sends out several branches, almost in the same manner with the artery.

From the concave side of the mesaraic vein, a little below the origin of the second branch, from the convex side, arises a branch, called *vena cæcalis*, which runs to the beginning of the colon, crossing one of the branches of the superior mesenteric artery.

This cæcal vein divides by two arches, the uppermost of which communicates with the lower branch of the vena gastro-colica; the other, after having sent ramifications to the intestinum cæcum and appendicula vermiformis, communicates below with the extremity of the great mesaraic vein.

The splenic vein is one of the three great branches of the vena portæ. It runs transversely from the right to the left, first under the duodenum, and then along the lower side of the pancreas.

In this course it gives off several veins, viz. the vena coronaria ventriculi, pancreaticæ, galtrica, or gastro-epiploica sinistra, and epiploica sinistra. It likewise often gives origin to the hæmorrhoidalis interna, the third capital branch of the vena portæ.

It terminates afterwards by a winding course, being divided into several branches that go to the spleen; one of which produces the small veins called, by the ancients, *vasa brevia*.

The coronaria ventriculi runs along the small arch of that viscus toward the pylorus, where it joins and becomes continuous with the vena pylorica. In its passage, it gives several rami to the sides of the stomach.

The venæ pancreaticæ are several small branches

sent by the splenica to the pancreas, along its lower side.

The left gastric, or gastro-epiploic vein, goes out from the splenica, at the left extremity of the pancreas; from whence it runs to the great extremity of the stomach, and along the great arch, till it meets the gastrica dextra, which is continuous with the sinistra.

In its passage, it gives several branches to both sides of the stomach, which are distributed by numerous ramifications, form many areolæ, and communicate with the branches of the coronaria ventriculi.

At a small distance from its origin, this gastric vein sends out a branch, which is distributed to the omentum; and on this account it has been called *gastro-epiploica*.

The vena epiploica sinistra arises at the small extremity of the pancreas, and is ramified on the omentum, all the way to the colon, where it communicates with the hæmorrhoidalis interna.

Lastly, the vena splenica reaches the fissure of the spleen, which it enters through its whole length by several branches. It is from the most posterior of these branches that the veins are sent off to the great extremity of the stomach, formerly known by the name of *vasa brevia*, which communicate with the coronaria ventriculi and gastrica sinistra.

The internal hæmorrhoidal vein is one of the three great branches of the vena portæ, coming ordinarily from the beginning of the vena splenica, and sometimes from the extremity or angle of the bifurcation of the great trunk of the vena portæ.

At a small distance from its beginning, it gives to the duodenum a second vena duodenalis.

Afterwards it is divided into two branches, one superior or ascending, the other inferior or descending. The first runs to the upper part of the arch of the colon, where, after many ramifications, it communicates with a branch of the great mesaraica, with the ramifications of the gastro-epiploica sinistra, and with those of the neighbouring epiploica.

The inferior branch runs down on the left portion of the colon, on the lower incurvations of that intestine, and on the rectum, all the way to the anus. In this course, it supplies the mesocolon, and forms arches, which send out numerous small ramifications, which surround these intestines.

This vein has been named *hæmorrhoidalis*, from the tumours often found at its extremity next the anus, which are called *hæmorrhoides*. The word *interna* is added, to distinguish this vein from the hæmorrhoidalis externa, which comes from the vena hypogastrica, and with which this vein communicates by capillary ramifications.

## EXPLANATION OF PLATE XVII.

This plate represents the heart in situ, all the large arteries and veins, with some of the muscles, &c.

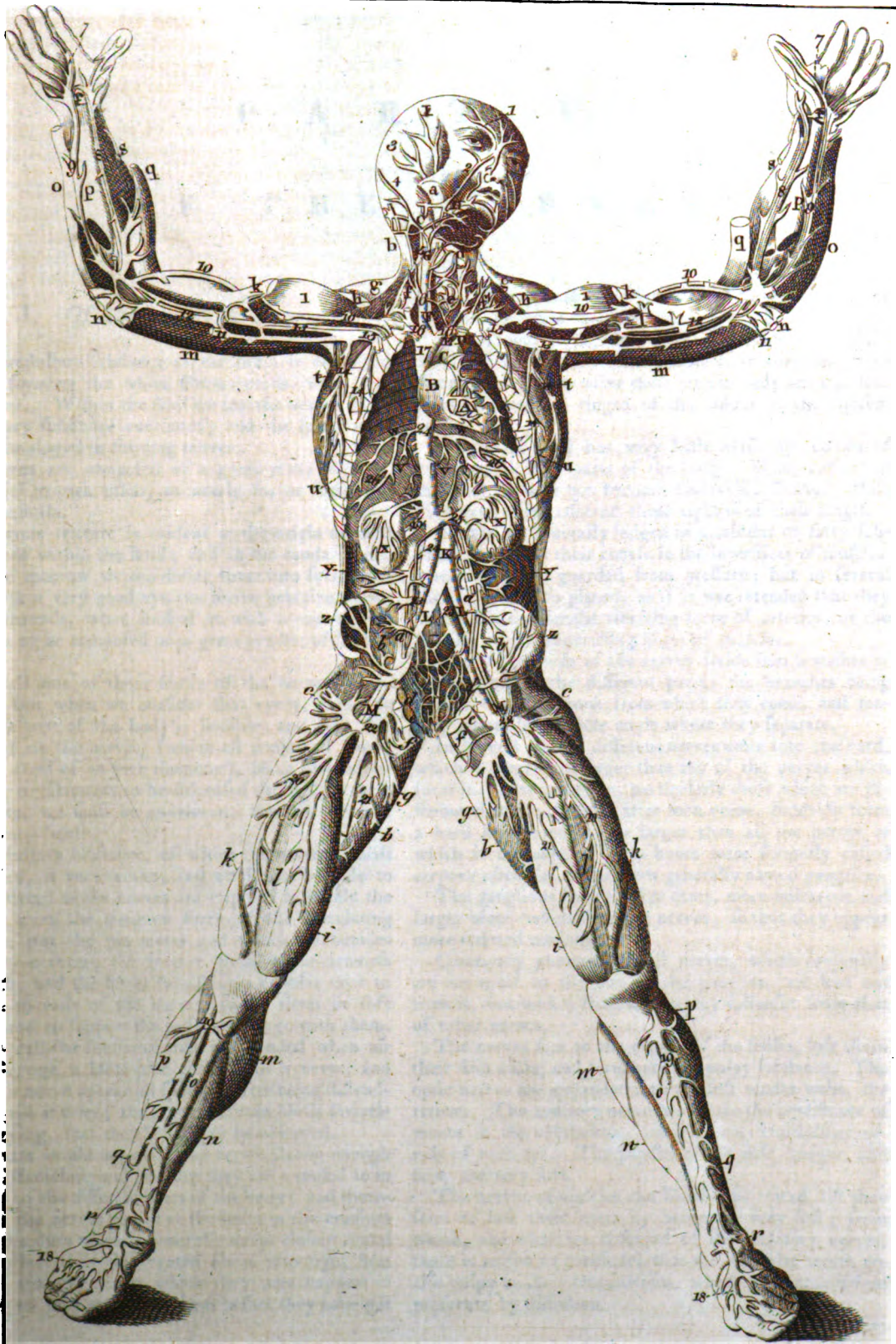
**MUSCLES.**—SUPERIOR EXTREMITY.—a, Masseter. b, Complexus. c, Diaphragmaticus. d, Os hyoides. e, Thyroid gland. f, Levator scapulæ. g, Cucullaris. h h, The clavicles cut. i, The deltoid muscle. k, Biceps flexor cubiti cut. l, Coraco-brachialis. m, Triceps extensor cubiti. n, The heads of the pronator teres, flexor carpi radialis, and flexor digitorum sublimis, cut. o, The flexor carpi ulnaris, cut at its extremity. p, Flexor digitorum profundus. q, Supinator radii longus, cut at its extremity. r, Ligamentum carpi transversale. s, Extensores carpi radiales. t, Latissimus dorsi. u, Anterior edge of the serratus anticus major. v, v, The inferior part of the diaphragm. w w, Its anterior edge cut. x x, The kidneys. y, Transversus abdominis. z, Os ilium.

**INFERIOR EXTREMITY.**—a, Psoas magnus. b, Iliacus internus. c, The fleshy origin of the tensor vaginæ femoris. d d, The ossa pubis cut from each other. e, Musculus pectineus cut from its origin. f, Short head of the triceps adductor femoris cut. g, The great head of the triceps. h, The long head cut. i, Vastus internus. k, Vastus externus. l, Cræpeus. m, Gemellus. n, Soleus. o, Tibia. p, Peronæus longus. q, Peronæus brevis. r, Fibula.

**HEART and BLOOD-VESSELS.**—A, The heart, with the coronary arteries and veins. B, The right auricle of the heart. C, The aorta ascendens. D, The left subclavian artery. E, The left carotid artery. F, The common trunk which sends off the

right subclavian and right carotid arteries. G, The carotis externa. H, Arteria facialis, which sends off the coronary arteries of the lips. I, Arteria temporalis profunda. K, Aorta descendens. L L, The iliac arteries,—which send off M M, The femoral or crural arteries. N. B. The other arteries in this figure have the same distribution as the veins of the same name:—And generally, in the anatomical plates, the description to be found on the one side, points out the same parts in the other. 1, The frontal vein. 2, The facial vein. 3, Vena temporalis profunda. 4, Vena occipitalis. 5, Vena jugularis externa. 6, Vena jugularis interna, covering the arteria carotis communis. 7, The vascular arch on the palm of the hand, which is formed by 8, the radial artery and vein, and 9, the ulnar artery and vein. 10 10, Cephalic vein. 11, Basilic vein, that on the right side, cut. 12, Median vein. 13, The humeral vein, which, with the median, covers the humeral artery. 14 14, The external thoracic, or mammary arteries and veins. 15, The axillary vein, covering the artery. 16 16, The subclavian veins, which, with (6 6) the jugulars, forms 17, the vena cava superior. 18, The cutaneous arch of veins on the fore-part of the foot. 19, The vena tibialis antica, covering the artery. 20, The vena profunda femoris, covering the artery. 21, The upper part of the vena saphena major. 22, The femoral vein. 23 23, The iliac veins. 24, 24, Vena cava inferior. 25 25, The renal veins covering the arteries. 26 26, The diaphragmatic veins.

PART



Albell Sculp.





P A R T V.  
O F T H E N E R V E S.

SECT. I. *Of the NERVES in general.*

**T**HE medullary substance of the brain is employed in forming the white fibrous cords, which are called *nerves*. Within the skull we see the nerves to be the medullary substance continued; and the spinal marrow is all employed in forming nerves.

The nerves are composed of a great many threads, lying parallel to each other, or nearly so, at their exit from the medulla.

This fibrous texture is evident at the origin of most of the nerves within the skull; and in the cauda equina of the spinal marrow we can divide them into such small threads, that a very good eye can scarce perceive them; but these threads, when looked at with a microscope, appear each to be composed of a great number of smaller threads.

How small one of these fibrils of the nerves is, we know not; but when we consider that every, even the most minute part of the body is sensible, and that this must depend on the nerves, (which all conjoined would not make a cord of an inch diameter), being divided into so many branches or filaments to be dispersed through all these minute parts, we must be convinced, that the nervous fibrils are very small.

The medullary substance, of which the nervous fibrils are composed, is very tender, and would not be able to resist such forces as the nerves are exposed to within the bones, nor even the common force of the circulating fluids, were not the pia mater and tunica arachnoides continued upon them; the former giving them firmness and strength, and the latter furnishing a cellular coat to connect the threads of the nerves, to let them lie soft and moist, and to support the vessels which go with them.

It is this cellular substance that is distended when air is forced through a blow-pipe thrust into a nerve, and that makes a nerve appear all spongy, after being distended with air till it dries; the proper nervous fibrils shrivelling so in drying, that they scarce can be observed.

These coats would not make the nerves strong enough to bear the stretching and pressure they are exposed to in their course to the different parts of the body; and therefore, where the nerves go out at the holes in the cranium and spine, the dura mater is generally wrapt closely round them, to collect their disgregated fibres into tight firm cords; and that the tension which they may happen to be exposed to may not injure them before they have got

this additional coat, it is firmly fixed to the sides of the holes in the bones through which they pass.

The nervous cords, thus composed of nervous fibrils, cellular coat, pia and dura mater, have such numerous blood-vessels, that, after their arteries only are injected, the whole cord is tinged of the colour of the injected liquor.

A nervous cord has very little elasticity, compared with several other parts of the body. When cut out of the body, it does not become observably shorter, while the blood-vessels contract three eighths of their length.

Nerves are generally lodged in a cellular or fatty substance, and have their course in the interstices of muscles, where they are guarded from pressure; but in several parts they are so placed, as if it was intended that they should there suffer the vibrating force of arteries, or the pressure of the contracting fibres of muscles.

The larger cords of the nerves divide into branches as they go off to the different parts; the branches being smaller than the trunk from which they come, and making generally an acute angle where they separate.

In several places, different nerves unite into one cord, which is commonly larger than any of the nerves which form it. Several nerves, particularly those which are distributed to the bowels, after such union, suddenly form a hard knot considerably larger than all the nerves of which it is made. These knots were formerly called *corpora olivaria*, and are now generally named *ganglions*.

The ganglions have thicker coats, more numerous and larger blood-vessels than the nerves; so that they appear more red and muscular.

Commonly numerous small nerves, which conjunctly are not equal to the size of the ganglion, are sent out from it, but with a structure no way different from that of other nerves.

The nerves sent to the organs of the senses, lose their firm coats, and terminate in a pulpy substance. The optic nerves are expanded into the soft tender webs, the retinae. The auditory nerve has scarce the consistence of mucus in the vestibulum, cochlea, and semicircular canals of each ear. The papillæ of the nose, tongue, and skin, are very soft.

The nerves of muscles can likewise be traced till they seem to lose their coats by becoming very soft; from which, and what we observed of the sensory nerves, there is reason to conclude, that the muscular nerves are also pulpy at their terminations, which we cannot indeed prosecute by dissection.

SECT.

SECT. II. *Of the particular NERVES.*

It is generally said, that there are forty pair of nerves in all; of which ten come out from the encephalon, and the other thirty have their origin from the spinal marrow.

Of the ten pair of nerves which come from the encephalon, the *first* is the OLFATORY, which have their origin from the corpora striata, near the part where the internal carotid arteries are about to send off their branches to the different parts of the brain; and in their course under the anterior lobes of the brain, which have each a depression made for lodging them, become larger, till they are extended to the cribriform bone; where they split into a great number of small filaments, to pass through the little holes in that bone; and being joined by a branch of the fifth pair of nerves, are spread on the membrane of the nose.

The tender structure and sudden expansion of these nerves on such a large surface, render it impossible to trace them far; which has made some authors deny them to be nerves: But when we break the circumference of the cribriform lamella, and then gently raise it, we may see the distribution of the nerves some way on the membrane of the nose.

The contrivance of defending these long soft nerves from being too much pressed by the anterior lobes of the brain under which they lie, is singular; because they have not only the prominent orbital processes of the frontal bone to support the brain on each side, with the veins going into the longitudinal sinus, and other attachments bearing it up, but there is a groove formed in each lobe of the brain itself for them to lodge in.—Their splitting into so many small branches before they enter the bones of the skull, is likewise peculiar to them; for generally the nerves come from the brain in disgregated filaments, and unite into cords, as they are going out at the holes of the bones. This contrivance is the best for answering the purpose they are designed for, of being the organ of smelling; for had they been expanded upon the membrane of the nose into a medullary web, such as the optic nerve forms, it would have been too sensible to bear the impressions of such objects as are applied to the nose; and a distribution in the more common way, of a cord sending off branches, would not have been equal enough for such an organ of sensation.

The *second* pair of nerves, the OPTIC, rising from the thalami nervorum opticorum, make a large curve outwards, and then run obliquely inwards and forwards, till they unite at the fore-part of the sella turcica; then soon divide, and each runs obliquely forwards and outwards to go out at its proper hole in the sphenoid bone, accompanied with the ocular artery, to be extended to the globe of the eye, within which each is expanded into a very fine cuplike web, that lines all the inside of the eye as far forwards as the ciliary circle, and is universally known by the name of RETINA.

Though the substance of this pair of nerves seems to be blended at the place where they are joined; yet observations of people whose optic nerves were not joined, and of others who were blind of one eye from a fault in

the optic nerve, or in those who had one of their eyes taken out, make it appear, that there is no such intimate union of substance; the optic nerve of the affected side only being wasted, while the other was large and plump. And the same observations are contradictory to the doctrine of a decussation of all the nerves, for the disease could be traced from the affected eye to the origin of the nerve on the same side.

These people whose optic nerves were not joined, having neither seen objects double, nor turned their eyes different ways, is also a plain proof, that the conjunction of the optic nerves will not serve to account for either the uniform motions of our eyes, or our seeing objects single with two eyes.

The retina of a recent eye, without any preparation, appears a very fine web, with some blood-vessels coming from its center to be distributed on it; but, after a good injection of the arteries that run in the substance of this nerve, as is common to other nerves, it is with difficulty that we can observe its nervous medullary substance.—The situation of these vessels in the central part of the optic nerve, the want of medullary fibres here, and the firmness of this nerve before it is expanded at its entry into the ball of the eye, may be the reason why we do not see such bodies, or parts of bodies, whose picture falls on this central part of the retina.

The THIRD PAIR rise from the anterior part of the processus annularis, and piercing the dura mater a little before, and to a side of the ends of the posterior clinoid process of the sphenoid bone, run along the receptacula; or cavernous sinuses, at the side of the ehippium, to get out at the foramina lacera; after which each of them divides into branches, of which one, after forming a little ganglion, is distributed to the globe of the eye; the others are sent to the musculus rectus of the palpebra, and to the attollens, adductor, deprimens, and obliquus minor muscles of the eye-ball. These muscles being principal instruments in the motions of the eye-lid and eye-ball; this nerve has therefore got the name of the MOTOR OCULI.

The FOURTH PAIR, which are the smallest nerves of any, derive their origin from the back-part of the base of the testes; and then making a long course on the side of the annular protuberance enter the dura mater a little farther back, and more externally than the third part, to run also along the receptacula, to pass out at the foramina lacera, and to be entirely spent on the muscoli trochleares, or superior oblique muscles of the eyes. These muscles being employed in performing the rotatory motions, and the advancement of the eye-balls forward, by which several of our passions are expressed, the nerves that serve them have got the name of PAINETIC.

The FIFTH PAIR are large nerves, rising from the annular processes where the medullary processes of the cerebellum join in the formation of that tuber, to enter the dura mater near the point of the petrous process of the temporal bones; and then sinking close by the receptacula at the sides of the sella turcica, each becomes in appearance thicker, and goes out of the skull in three great branches!

The *first* branch of the *fifth* is the OPHTHALMIC; which runs through the foramen lacera, to the orbit, having

having in its passage thither a connection with the sixth pair. It is afterwards distributed to the ball of the eye with the third; to the nose, along with the olfactory, which the branch of the fifth that passes through the foramen orbitarium internum joins, as was already mentioned in the description of the first pair. This ophthalmic branch likewise supplies the parts at the internal canthus of the orbit, the glandula lacrymalis, fat, membranes, muscles, and teguments of the eye-lids; its longest farthest extended branch passing through the foramen superciliare of the os frontis, to be distributed to the forehead.

The *second* branch of the *fifth* pair of nerves may be called *MAXILLARIS SUPERIOR*, from its serving principally the parts of the upper jaw. It goes out at the round hole of the sphenoid bone, and sends immediately one branch into the channel on the top of the antrum maxillare; the membrane of which and the upper teeth are supplied by it in its passage. As this branch is about to go out at the foramen orbitarium externum, it sends a nerve through the substance of the os maxillare to come out at Steno's duct, to be distributed to the fore-part of the palate; and what remains of it escaping at the external orbital hole, divides into a great many branches, that supply the cheek, upper lip, and nostril. The next considerable branch of the superior maxillary nerve, after giving branches which are reflected through the sixth hole of the sphenoid bone, to join the intercostal where it is passing through the skull with the carotid artery, and the portio dura of the seventh pair, as it passes through the os petrosum, is sent into the nose by the hole common to the palate and sphenoidal bone; and the remaining part of this nerve runs in the palato-maxillaris canal, giving off branches to the temples and pterygoid muscles, and comes at last into the palate to be lost.

The *third* or *MAXILLARIS INFERIOR* branch of the *fifth* pair going out at the oval hole of the sphenoid bone, serves the muscles of the lower jaw, and the muscles situated between the os hyoides and jaw: All the salivary glands, the amygdalæ, and the external ear, have branches from it: It has a large branch lost in the tongue, and sends another through the canal in the substance of the lower jaw to serve all the teeth there, and to come out at the hole in the fore-part of the jaw, to be lost in the chin and under lip.

The *SIXTH PAIR*, which is the smallest except the fourth, rises from the fore-part of the corpora pyramidalia; and each entering the dura mater some way behind the posterior clinoid process of the sphenoid bone, has a long course below that membrane, and within the receptaculum at the side of the sella turcica, where it is immersed in the blood of the receptacle: It goes afterwards out at the foramen lacerum into the orbit, to serve the abductor muscle of the eye.—A defect in this nerve may therefore be one cause of a strabismus.—In the passage of this nerve below the dura mater, it lies very contiguous to the internal carotid artery, and to the ophthalmic branch of the fifth pair of nerves. At the place where the sixth pair is contiguous to the carotid, a nerve either goes from each of them in an uncommon way, to wit, with the angle beyond where it rises obtuse, to descend with the artery, and to form the beginning of the

intercostal nerve, according to the common description; or, according to other authors, this nerve comes up from the great ganglion of the intercostal, to be joined to the sixth here.

The *SEVENTH PAIR* comes out from the lateral part of the annular process behind where the medullary process of the cerebellum are joined to that tuber; and each being accompanied with a larger artery than most other nerves, enters the internal meatus auditorius, where the two large bundles of fibres, of which it appeared to consist within the skull, soon separate from each other; one of them entering by several small holes into the vestibule, cochlea, and semicircular canals, is stretched on this inner camera of the ear in a very soft pulpy substance; and being never seen in the form of a firm cord, such as the other parcel of this and most other nerves become, is called *PORTIO MOLLIS* of the auditory nerve.

The other part of this seventh pair passes through Galen's foramen cæcum, or Fallopius's aquæduct, in its crooked passage by the side of the tympanum; in which passage, a nerve sent from the lingual branch of the inferior maxillary nerve, along the outside of the tuba Eustachiana, and crosses the cavity of the tympanum, where it has the name of *chorda tympani*, is commonly said to be joined to it. The very acute angle which this nerve makes with the fifth, or the sudden violent reflection it would suffer on the supposition of its coming from the fifth to the seventh, appears unusual; whereas, if we suppose that it comes from the seventh to the fifth, its course would be more in the ordinary way, and the *chorda tympani* would be esteemed a branch of the seventh pair going to join the fifth, the size of which is increased by this acquisition. This smaller bundle of the seventh gives branches to the muscles of the malleus, and to the dura mater, while it passes through the bony crooked canal, and at last comes out in a firm chord named *PORTIO DURA*, at the end of this canal, between the styloid and mastoid processes of the temporal bone, giving immediately filaments to the little oblique muscles of the head, and to those that rise from the styloid process. It then pierces through the parotid gland, and divides into a great many branches, which are dispersed in the muscles and teguments that cover all the side of the upper part of the neck, the whole face and cranium, as far back as the temples, including a considerable part of the external ear.

The *EIGHTH PAIR* of nerves rise from the lateral bases of the corpora olivaria in disgregated fibres; and as they are entering the anterior internal part of the holes common to the os occipitis and temporum, each is joined by a nerve which ascends within the dura mater from the tenth of the head, the first, second and inferior cervical nerves: This every body knows has the name of the *NERVUS ACCESSORIUS*. When the two get out of the skull, the *accessorius* separates from the eighth, and, descending obliquely outwards, passes through the sterno-mastoid muscle, to which it gives branches, and afterwards terminates in the trapezius and rhomboid muscles of the scapula. In this course it is generally more or less joined by the second cervical nerve.

The large *EIGHTH PAIR*, soon after its exit, gives

nerves to the tongue, larynx, pharynx, and ganglion of the intercostal nerve, and being disjoined from the ninth and intercostal, to which it adheres closely some way, runs straight down the neck behind the internal jugular vein, and at the external side of the carotid artery. As it is about to enter the thorax, a large nerve goes off from the eight of each side: This branch of the right-side turns round from the fore to the back part of the subclavian artery, while the branch of the left-side turns round the great curve of the aorta; and both of them mounting up again at the side of the œsophagus, to which they give branches, are lost at last in the larynx. These are called the RECURRENT nerves, which we are desired to shun in the operation of bronchotomy, though their deep situation protects them sufficiently.

The eighth pair, above, and at or near the place where the recurrent nerves go off from it, or frequently the recurrences themselves, send off small nerves to the pericardium, and to join with the branches of the intercostal that are distributed to the heart; but their size and situation are uncertain.

After these branches are sent off, the par vagum on each side descends behind the great branch of the trachea, and gives numerous filaments to the lungs, and some to the heart in going to the œsophagus. The one of the left-side running on the fore-part of the œsophagus, communicates by several branches with the right one in its descent to be distributed to the stomach: The right one gets behind the œsophagus, where it splits and rejoins several times before it arrives at the stomach, to which it sends nerves; and then being joined by one or more branches from the left trunk, they run towards the cœliac artery, there to join into the great semilunar ganglion formed by the two intercostals.

The NINTH PAIR of nerves comes from the inferior part of the corpora pyramidalia, to go out of the skull at their proper holes of the occipital bone. After their egress they adhere for some way firmly to the eighth and intercostal; and then sending a branch, that in many subjects is joined with branches of the first and second cervical nerves, to be distributed to the thyroid gland and muscles on the fore-part of the trachea arteria, the ninth is lost in the muscles and substance of the tongue.

The TENTH PAIR rises in separate threads from the sides of the spinal marrow, to go out between the os occipitis and first vertebra of the neck. After each of them has given branches to the great ganglion of the intercostal, 8th, 9th, and 1st cervical nerves, it is distributed to the straight, oblique, and some of the extensor muscles of the head.

The branch reflected from the sixth pair, joined possibly by some filaments of the ophthalmic branch of the fifth, runs along with the internal carotid artery, through the crooked canal formed for it in the temporal bone, where the little nerve is very soft and pappy, and in several subjects divides and unites again, and is joined by one or more branches from the fifth particularly of its superior maxillary branch, before it comes out of the skull. As soon as the nerve escapes out of this bony canal, it is connected a little way with the eighth and ninth; then separating from these, after seeming to receive addition-

al nerves from them, it forms a large ganglion, into which branches from the tenth of the head, and from the first and second cervical, enter. From this ganglion the nerves come out again small, to run down the neck along with the carotid artery, communicating by branches with the cervical nerves, and giving nerves to the muscles that bend the head and neck. As the intercostal is about to enter the thorax, it forms another ganglion, from which nerves are sent to the trachea and to the heart; these designed for the heart joining with the branches of the eighth, and most of them passing between the two great arteries and the auricles, to the substance of that muscle. The intercostal after this consisting of two branches, one going behind, and the other running over the fore-part of the subclavian artery, forms a new ganglion where the two branches unite below that artery, and then descending along the sides of the vertebræ of the thorax, receives branches from each of the dorsal nerves; which branches appearing to come out between the ribs, have given the name of intercostal to the whole nerve. Where the addition is made to it from the fifth dorsal nerve, a branch goes off obliquely forwards; which being joined by such branches from the sixth, seventh, eighth, and ninth dorsal, an anterior trunk is formed, and passes between the fibres of the appendix musculosa of the diaphragm, to form, along with the other intercostal and the branches of the eighth pair, a large semilunar ganglion situated between the cœliac and superior mesenteric arteries; the roots of which are as it were involved in a sort of nervous net-work of this ganglion, from which a great number of very small nervous threads run out to be extended on the surface of all the branches of those two arteries, so as to be easily seen when any of the arteries are stretched, but not to be raised from them by dissection; and thus the liver, gall-bladder, duodenum, pancreas, spleen, jejunum, ilium, and a large share of the colon, have their nerves sent from this great solar ganglion or plexus.

Several fibres of this ganglion, running down upon the aorta, meet with other nerves sent from the posterior trunk of the intercostal, which continues its course along the sides of the vertebra, they supply the glandulæ renales, kidneys, and testes in men, or ovaria in women; and then they form a net-work upon the inferior mesenteric artery where the nerves of the two sides meet, and accompany the branches of this artery to the part of the colon that lies in the left side of the belly, and to the rectum, as far down as to the lower part of the pelvis.

The intercostal continuing down by the side of the vertebræ of the loins, is joined by nerves coming from between these vertebræ, and sends nerves to the organs of generation and others in the pelvis, being even joined with those that are sent to the inferior extremities.

The SPINAL NERVES rise generally by a number of disgregated fibres from both the fore and back part of the medulla spinalis, and soon after form a little knot or ganglion, where they acquire strong coats, and are extended into firm cords. They are distinguished by numbers, according to the vertebræ from between which they come out; the superior of the two bones forming the hole through which they pass, being the one from which the

number

number is applied to each nerve. There are generally said to be *thirty pair* of them; seven of which come out between the vertebræ of the neck, twelve between those of the back, five between those of the loins, and six from the false vertebræ.

The **FIRST CERVICAL** pair of nerves comes out between the first and second vertebræ of the neck; and having given branches to join with the tenth pair of the head, the second cervical and intercostal, and to serve the muscles that bend the neck, it sends its largest branches backwards to the extensor muscles of the head and neck; some of which piercing through these muscles, run up on the occiput to be lost in the teguments here; and many fibres of it advance so far forward as to be connected with the fibrils of the first branch of the fifth pair of the head, and of the portio dura of the auditory nerve.

The **SECOND CERVICAL** is soon joined, by some branches, to the ninth of the head and intercostal, and to the first and third of the neck; then has a large branch that comes out at the exterior edge of the sterno-mastoidæus muscle, where it joins with the accessorius of the eighth pair; and is afterwards distributed to the platysma myoides, teguments of the side of the neck and head, parotid gland, and external ear, being connected to the portio dura of the auditory nerve, and to the first cervical. The remainder of this second cervical is spent on the levator scapulæ and the extensors of the neck and head. Generally a large branch is here sent off to join the accessorius of the eighth pair, near the superior angle of the scapula.

The **THIRD PAIR** of the neck passes out between the third and fourth cervical vertebræ; having immediately a communication with the second, and sending down a branch, which being joined by a branch from the fourth cervical, forms the **PHRENIC** nerve. This descending, enters the thorax, between the subclavian vein and artery; and then being received into a groove, formed for it in the pericardium, it has its course along this capsule of the heart, till it is lost in the middle part of the diaphragm. The right phrenic has a straight course; but the left one is obliged to make a considerable turn outwards, to go over the prominent part of the pericardium, where the point of the heart is lodged.—The middle of the diaphragm scarce could have been supplied by any other nerve which could have had such a straight course as the phrenic has.

The other branches of the third cervical nerve are distributed to the muscles and teguments at the lower part of the neck and top of the shoulder.

The **FOURTH CERVICAL** nerve, after sending off that branch which joins with the third to form the phrenic, and bestowing twigs on the muscles and glands of the neck, runs to the arm-pit, where it meets with the **FIFTH, SIXTH, and SEVENTH** cervicals, and **FIRST DORSAL**, that escape in the interstices of the muscoli scaleni, to come at the arm-pit, where they join, separate, and rejoin, in a way scarce to be rightly expressed in words; and, after giving several considerable nerves to the muscles and teguments which cover the thorax, they divide into several branches, to be distributed to all the

parts of the superior extremity. Seven of these branches we shall describe under particular names.

1. **SCAPULARIS** runs straight to the cavitas femilunata of the upper costa of the scapula, which is a hole, in the recent subject, by a ligament being extended from one angle of the bone to the other, giving nerves in its way to the muscles of the scapula. When it has passed this hole, it supplies the supra-spinatus muscle; and then descending at the anterior root of the spine of the scapula, it is lost in the other muscles that lie on the dorsum of that bone.

2. **ARTICULARIS** sinks downward at the axilla, to get below the neck of the head of the os humeri, and to mount again at the back-part of it; so that it almost surrounds the articulation, and is distributed to the muscles that draw the arm back, and to those that raise it up.

3. **CUTANEUS** runs down the fore-part of the arm, near the skin, to which it gives off branches; and then divides, on the inside of the fore-arm, into several nerves, which supply the teguments there, and on the palm of the hand.

4. **MUSCULO-CUTANEUS**, or *perforans Casseri*, passes through the coraco-brachialis muscle; and, after supplying the biceps flexor cubiti and brachii internus, passes behind the tendon of the biceps, and over the cephalic vein, to be bestowed on the teguments on the outside of the fore-arm and back of the hand.

5. **MUSCULARIS** has a spiral course from the axilla, under the os humeri, and backward to the external part of that bone, supplying by the way the extensor muscles of the fore-arm, to which it runs between the two brachii muscles, and within the supinator radii longus.—At the upper part of the fore-arm, it sends off a branch, which accompanies the supinator longus till it comes near the wrist, where it passes obliquely over the radius, to be lost in the back of the hand and fingers. The principal part of this nerve pierces through the supinator radii brevis, to serve the muscles that extend the hand and fingers, whose actions are not injured when the supinator acts.

6. **ULNARIS** is extended along the inside of the arm, to give nerves to the muscles that extend the fore-arm, and to the teguments of the elbow: Towards the lower part of the arm, it slants a little back-ward, to come at the groove behind the internal condyle of the os humeri, through which it runs to the ulna: In its course along this bone, it serves the neighbouring muscles and teguments; and as it comes near the wrist, it detaches a branch obliquely over the ulna to the back of the hand, to be lost in the convex part of several fingers. The larger part of the nerve goes straight forward to the internal side of the os pisiforme of the wrist; where it sends off a branch which sinks under the large tendons in the palm, to go cross to the other side of the wrist, serving the muscoli lumbricales and interossei, and at last terminating in the short muscles of the thumb and fore-finger. What remains of the ulnar nerve, after supplying the short muscles of the little finger, divides into three branches; whereof two are extended along the sides of the sheath of the tendons of the flexors of the little finger, to furnish the concave side of that finger; and the third

third branch is disposed in the same way upon the side of the ring-finger next to the little finger.

When we lean or press on the internal condyle of the os humeri, the numbness and prickling we frequently feel, point out the course of this nerve.

7. **RADIALIS** accompanies the humeral artery to the bending of the elbow, serving the flexors of the cubit in its way; then passing through the pronator radii teres muscle, it gives nerves to the muscles on the fore-part of the forearm, and continues its course near to the radius, bestowing branches on the circumjacent muscles. Near the wrist, it sometimes gives off a nerve, which is distributed to the back of the hand, and the convex part of the thumb, and several of the fingers, instead of the branch of the muscular. The larger part of this nerve, passing behind the annular ligament of the wrist, gives nerves to the short muscles of the thumb; and afterwards sends a branch along each side of the sheath of the tendons of the flexors of the thumb, fore-finger, mid-finger, and one branch to the side of the ring-finger, next to the middle one, to be lost on the concave side of those fingers.

Though the radial nerve passes through the pronator muscle, and the muscular nerve seems to be still more unfavourably placed within the supinator brevis; yet the action of these muscles do not seem to have any effect in hindering the influence of these nerves, for the fingers or hand can be bended while pronation is performing vigorously, and they can be extended while supination is exercised.

The manner of the going off of these nerves of the fingers, both from the ulnar and radial, is, that a single branch is sent from the trunk to the side of the thumb and little finger, farthest from the other fingers; and all the rest are supplied by a trunk of a nerve, which splits into two some way before it comes as far as the end of the metacarpus, to run along the sides of different fingers that are nearest to each other.

It might have been observed, that, in describing the posterior branches of the ulnar and muscular nerve, we did not mention the particular fingers, to the convex part of which they are distributed. The reason of this omission is, the uncertainty of their distribution; for though sometimes these posterior branches go to the same fingers, to the concave part of which the anterior branches of the ulnar and radial are sent, yet frequently they are distributed otherwise.

The situation of these brachial nerves in the axilla, may let us see how a weakness and atrophy may be brought on the arms by a long continued pressure of crutches, or such other hard substances on this part; and the course of them from the neck to the arm, may reach us, how much better effects vesicatories, or stimulating nervous medicines, would have, when applied to the skin, covering the transverse processes of the vertebrae of the neck, or at the axilla, than when they are put between the shoulders, or upon the spinal processes, in convulsions or palsies of the superior extremities, where a stimulus is required.

The **TWELVE DORSAL** nerves of each side, as soon as they escape from between the vertebrae, send a branch

forward to join the intercostal, by which a communication is made among them all; and they soon likewise give branches backwards to the muscles that raise the trunk of the body, their principal trunk being extended outwards, to come at the furrow in the lower edge of each rib, in which they run toward the anterior part of the thorax, between the internal and external intercostal muscles, giving off branches in their course to the muscles and teguments of the thorax.

The **FIRST** dorsal, as was already observed, is particular in this, that it contributes to form the brachial nerves; and that the two branches of the intercostal, which come down to the thorax, form a considerable ganglion with it.

The **SIX** lower dorsal nerves give branches to the diaphragm and abdominal muscles.

The **TWELFTH** joins with the first lumbar, and bestows nerves on the musculus quadratus lumborum and iliacus internus.

As the intercostal is larger in the thorax than any where else, and seems to diminish gradually as it ascends and descends, there is cause to suspect that this is the trunk from which the superior and inferior pairs are sent as branches.

The **FIVE LUMBAR** nerves on each side communicate with the intercostal and with each other, and give branches backwards to the loins.

The **FIRST** communicates with the last dorsal, sends branches to the abdominal muscles, to the psoas and iliacus, and to the teguments and muscles on the fore-part of the thigh; while its principal branch joins with the other nerves, to form the crural nerve.

The **SECOND LUMBAR** nerve passes through the psoas muscle, and is distributed nearly in the same way as the former: as is also the **THIRD**.

Branches of the *second, third, and fourth*, make up one trunk, which runs along the fore-part of the pelvis; and, passing in the notch at the fore-part of the great hole common to the os pubis and ischium, is spent on the adductor muscles, and on the teguments on the inside of the thigh. This nerve is called the **OBTURATOR, OR POSTERIOR CRURAL NERVE**.

By united branches from the *first, second, third, and fourth* lumbar nerves, a nerve is formed that runs along the psoas muscle, to escape with the external iliac vessels out of the abdomen, below the tendinous arcade of the external oblique muscle. This nerve, which is named the **ANTERIOR CRURAL**, is distributed principally to the muscles and teguments on the fore-part of the thigh. A branch, however, of this nerve runs down the inside of the leg to the upper part of the foot, keeping near to the vena saphæna; in opening of which with a lancet at the ankle, the nerve is sometimes hurt, and occasions sharp pain at the time of the operation, and numbness afterwards.

The **SIXTH PAIR** of the false **VERTEBRÆ** consist each of small posterior branches, sent to the hips, and of large anterior branches.

The *first, second, and third*, after coming through the three upper holes in the fore-part of the os sacrum, join together with the fourth and fifth of the loins, to form

form the largest nerve of the body, which is well known by the name of **SCIATIC** or **ISCHIATIC** nerve: This, after sending large nerves to the different parts of the pelvis, and to the external parts of generation, and the podex, as also to the muscles of the hips, passes behind the great tuber of the os ischium, and then over the quadrigemi muscles, to run down near to the bone of the thigh at its back-part, giving off nerves to the neighbouring muscles and teguments. Some way above the ham, where it has the name of the *popliteus* nerve, it sends off a large branch that passes over the fibula, and sinking in among the muscles on the anterior external part of the leg, runs down to the foot, to be lost in the upper part of the larger toes, supplying the neighbouring muscles and teguments every where in its passage. The larger branch of the sciatic, after giving branches to the muscles and teguments about the ham and knee, and sending a large cutaneous nerve down the calf of the leg, to be lost at last on the outside of the foot and upper part of the lesser toes, sinks below the gemellus muscle, and distributes nerves to the muscles on the back of the leg; among which it continues its course, till passing behind the internal malleolus, and in the internal hollow of the os calcis, it divides into the two plantar nerves: The internal of which is distributed to the toes, in the same manner that the radial nerve of the hand serves the concave side of the thumb and fingers; and the external plantar is divided and distributed to the sole of the foot and toes, nearly as the ulnar nerve is in the palm of the hand, and in the concave part of the fingers.

Several branches of these nerves, that serve the inferior extremities, pierce through muscles.

The **FOURTH**, which, with the two following, is much smaller than the three superior, soon is lost in the vesica urinaria and intestinum rectum.

The **FIFTH** comes forward between the extremity of

the os sacrum and coccygis, to be distributed principally to the levatores asi.

The **SIXTH**, which some think to be only a production of the dura mater, advances forward below the broad shoulders of the first bone of the os coccygis, and is lost in the sphincter ani and teguments covering it.

The size of the nerves of the inferior extremities seems larger proportionally than in the superior extremities; the inferior extremities having the weight of the whole body to sustain, and that frequently at a great disadvantage.—What the effect is of the nerves here being injured, we see daily, when people happen, by sitting wrong, to compress the sciatic nerve, they are incapable for some time after to support themselves on the affected extremity; and this is still more remarkable in the sciatic or hip-gout, in which the member is not only weakened, but gradually shrivels and wastes.

#### USES of the Nerves.

**MANY** experiments concur in proving, that the nerves are the instruments of sensation. As to the mode of their operation, several different theories have been given. Some suppose, that they are elastic cords, resembling fiddle-strings; and that they convey sensations to the brain by a kind of vibratory motion. Others have supposed them to be tubular, and to contain a fluid called *animal spirits*; and that sensation is produced by the motions and counter-motions of this fluid. Many useless volumes have been wrote upon each of these hypotheses.—Another and more recent theory supposes, that the nerves are not tubular, but that they are pervaded by a subtile elastic fluid called *Æther*; and that sensation, &c. are occasioned by the oscillations of that fluid. A few detached and ill-digested scraps of this theory have already appeared in some temporary productions, the principal of which has been sufficiently animadverted upon under the word **ÆTHER**.

## EXPLANATION OF PLATE XVIII.

**FIG. 1.** Represents the inferior part of the brain;—the anterior part of the whole spine, including the medulla spinalis;—with the origin and large portions of all the **NERVES**.

**A A**, The anterior lobes of the cerebrum. **B B**, The lateral lobes of the cerebrum. **C C**, The two lobes of the cerebellum. **D**, Tuber annulare. **E**, The passage from the third ventricle to the infundibulum. **F**, The medulla oblongata, which sends off the medulla spinalis through the spine. **G G**, That part of the os occipitis which is placed above (**H H**), the transverse processes of the first cervical vertebra. **I I**, &c. The seven cervical vertebræ, with their intermediate cartilages. **K K**, &c. The twelve dorsal vertebræ, with their intermediate cartilages. **L L**, &c. The five lumbar vertebræ, with their intermediate cartilages. **M**, The os sacrum. **N**, The os coccygis.

**NERVES**.—**1 1**, The first pair of nerves, named *olfactory*, which go to the nose. **2 2**, The second pair, named *optic*, which goes to form the tunica retina of the eye. **3 3**, The third pair, named *motor oculi*; it supplies most of the muscles of the eye-ball.

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rynx,

**4 4**, The fourth pair, named *pathetic*,—which is wholly spent upon the musculus trochlearis of the eye.

**5 5**, The fifth pair divides into three branches.—The first, named *ophthalmic*, goes to the orbit, supplies the lachrymal gland, sends branches out to the forehead and nose.—The second, named *superior maxillary*, supplies the teeth of the upper jaw, and some of the muscles of the lips.—The third, named *inferior maxillary*, is spent upon the muscles and teeth of the lower jaw, tongue, and muscles of the lips.

**6 6**, The sixth pair, which, after sending off the beginning of the intercostal or great sympathetic, is spent upon the abductor oculi.

**7 7**, The seventh pair, named *auditory*, divides into two branches.—The largest, named *portio mollis*, is spent upon the internal ear.—The smallest, *portio dura*, joins to the fifth pair within the internal ear by a reflected branch from the second of the fifth, and within the tympanum, by a branch from the third of the fifth, named *chorda tympani*.—Vid. fig. 3. near B.

**8 8**, &c. The eighth pair, named *par vagum*,—which accompanies the intercostal, and is spent upon the tongue, larynx, pharynx,

rynx, lungs, and abdominal viscera. 9 9, The ninth pair, which are spent upon the tongue. 10 10, &c. The intercostal, or great sympathetic, which is seen from the sixth pair to the bottom of the pelvis on each side of the spine, and joining with all the nerves of the spine;—in its progress supplying the heart, and, with the par vagum, the contents of the abdomen and pelvis. 11 11, The accessorius, which is spent upon the sterno-cleido mastoideus and trapezius muscles. 12 12, The first cervical nerves;—13 13, The second cervical nerves;—both spent upon the muscles that lie on the neck, and teguments of the neck and head. 14 14, The third cervical nerves, which, after sending off (15 15, &c.) the phrenic nerves to the diaphragm,—supply the muscles and teguments that lie on the side of the neck and top of the shoulder. 16 16, The brachial plexus, formed by the fourth, fifth, sixth, seventh cervicals, and first dorsal nerves,—which supply the muscles and teguments of the superior extremity. 17 17, The twelve dorsal, or proper intercostal nerves, which are spent upon the intercostal muscles and some of the large muscles which lie upon the thorax. 18 18, The five lumbar pairs of nerves, which supply the lumbar and abdominal muscles, and some of the teguments and muscles of the inferior extremity. 19 19, The sacro-sciatic, or posterior crural nerve, formed by the two inferior lumbar, and three superior of the os fa-

crum.—This large nerve supplies the greatest part of the muscles and teguments of the inferior extremity. 20, The stomachic plexus, formed by the eighth pair. 21 21, Branches of the solar or celiac plexus, formed by the eighth pair and intercostals, which supply the stomach and chylopoetic viscera. 22 22, Branches of the superior and inferior mesenteric plexuses, formed by the eighth pair and intercostals, which supply the chylopoetic viscera, with part of the organs of urine and generation. 23 23, Nerves which accompany the spermatic cord. 24 24, The hypogastric plexus, which supplies the organs of urinae and generation within the pelvis.

FIG. 2, 3, 4, 5. Shews different views of the inferior part of the brain, cut perpendicularly through the middle,—with the origin and large portions of all the nerves which pass out through the bones of the cranium,—and the three first cervicals.

A, The anterior lobe. B, The lateral lobe of the cerebrum. C, One of the lobes of the cerebellum. D, Tuber annulare. E, Corpus pyramidale, in the middle of the medulla oblongata. F, The corpus olivare, in the side of the medulla oblongata. G, The medulla oblongata. H, The medulla spinalis.

NERVES.—1 2 3 4 5 6 7 8 & 9, Pairs of nerves. 10 10, Nervus accessorius, which comes from—11 12 & 13, the three first cervical nerves.

## P A R T VI.

*Of such Parts of the Body as could not properly be described under any of the former general Divisions.*

### SECT. I. *Of the common Integuments.*

#### THE SKIN.

THE skin is a substance of very large extent, made up of several kinds of tendinous, membranous, vascular, and nervous fibres, the intertexture of which is so much the more wonderful, as it is difficult to unfold; for their directions are as various as those of the stuff of which an hat consists.

This texture is what we commonly call leather, and it makes, as it were, the body of the skin. It is not easily torn, may be elongated in all directions, and afterwards recovers itself, as we see in fat persons, in women with child, and in swellings; and it is thicker and more compact in some places than in others.

Its thickness and compactness are not, however, always proportionable; for on the posterior parts of the body, it is thicker and more lax than on the fore-parts; and on the palms of the hands, and soles of the feet, it is both very thick and very solid.

The outer surface of this substance is furnished with small eminences, which anatomists have thought fit to

call *papilla*, in which the capillary filaments of the cutaneous nerves terminate by small radiated pencils.

These papillæ differ very much in figure and disposition in the different parts of the body, and they may be distinguished into several kinds.

The greatest part of them is flat, of different breadths, and separated by sulci, which form a kind of irregular lozenges. The pyramidal figure ascribed to them, is not natural, and appears only when they are contracted by cold or by diseases.

The papillæ of the palm of the hand, of the sole of the foot, and of the fingers and toes, are higher than on the other parts of the body; but they are likewise smaller, closely united together, and placed as it were endwise, with respect to each other, in particular rows, which represent on the skin all kinds of lines, straight, crooked, waving, spiral, &c. These several lines are often distinctly visible in those parts of the palm of the hand which are next the first phalanges of the fingers.

The red part of the lips is made up of papillæ, representing very fine hairs or villi, closely united together.

There is another particular kind under the nails; the papillæ being there more pointed, or in a manner conical, and turned obliquely towards the ends of the fingers.

Those



Fig. 1.

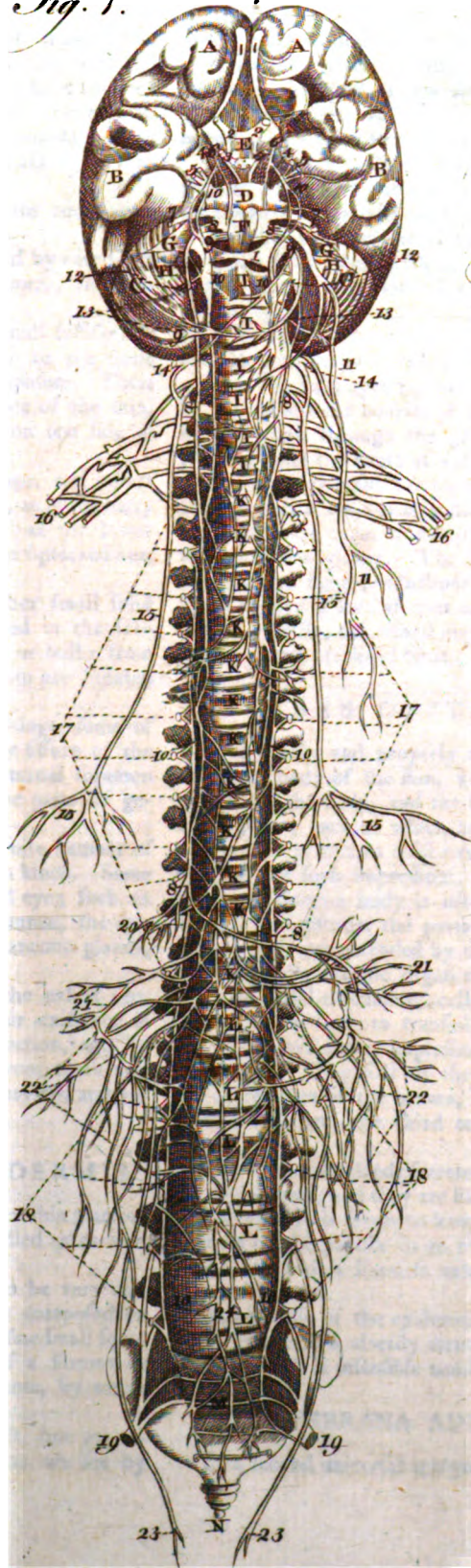


Fig. 2.



Fig. 3.



Fig. 4.

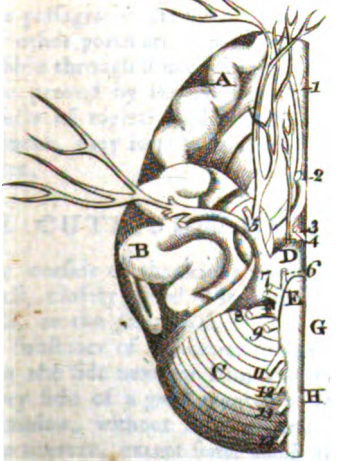
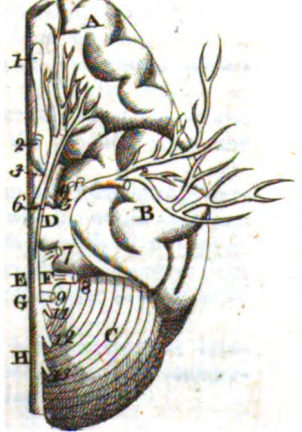


Fig. 5.





Those which are found in the hairy scalp, scrotum, &c. are still of other kinds.

The papillæ of the first and second kinds appear to be surrounded at their bases by a soft mucilaginous and pretty viscid substance, which fills the interstices between them, and represents a kind of net-work or sieve, the meshes or holes of which surround each papilla. This substance is commonly called *corpus reticulare*, or *muscosum*.

This vascular texture is of various forms and figures in the different parts of the body.

The inner surface of the skin is covered by very small tubercles, commonly called *cutaneous glands*, or *glandulæ miliaris*.

These tubercles are partly fixed in small fossulæ, in the substance of the skin, which answer to the same number of small cavities in the corpus adiposum. Their excretory ducts open on the outer surface of the skin, sometimes in the papillæ, and sometimes on one side of them.

The greatest part of them furnishes sweat, and others a fatty oily matter of different thickneses, as in the hairy scalp, in the back, behind the ears, and at the lower part of the nose, where this matter may be squeezed out, in form of small worms.

Besides these corpuscles, there are other small solid bodies, almost of an oval figure, contained in the substance of the skin. These are the roots or bulbs from whence the hairs arise, and some of them are situated within the inner surface of the skin.

The skin has several considerable openings, some of which have particular names; such as the fissure of the palpebræ, the nares, the mouth, the external foramen of the ears, the anus, and openings of the parts of generation.

Besides these, it is perforated by an infinite number of small holes, called *pores*, which are of two kinds. Some are more or less perceivable to the naked eye; such as the orifices of the milky ducts of the mammæ, the orifices of the excretory canals of the cutaneous glands, and the passages of the hairs.

The other pores are imperceptible to the naked eye, but visible through a microscope; and their existence is likewise proved by the cutaneous transpiration, and by the effects of topical applications; and from these two phenomena, they have been divided into arterial and venal pores.

### THE CUTICULA, OR EPIDERMIS.

The outside of the skin is covered by a thin transparent web, closely joined to it, which is called *epidermis*, *cuticula*, or the *scarf-skin*.

The substance of the cuticula appears to be very uniform on the side next the skin, and to be composed on the other side of a great number of very fine small squamous laminae, without any appearance of a fibrous or vascular texture, except some small filaments, by which it is connected to the papillæ.

This substance is very solid and compact, but yet capable of being extended and thickened, as we see by

steeping it in water, and by the blisters raised on the skin by vesicatories. It yields very much in swellings; but not so much as the skin, without breaking or cracking.

Hard and reiterated frictions loosen it insensibly, and presently afterward, a new stratum arises, which thrusts the first outward, and may itself be loosened and thrust outward by a third stratum, and so on.

The epidermis adheres very closely to the cutaneous papillæ, from which it may be separated by boiling; or by steeping, for a long time, in cold water.

It adheres still closer to the corpus reticulare, which is easily raised along with it; and they seem to be true portions or continuations of each other.

The epidermis covers the skin through its whole extent, except at the places where the nails lie. It is marked with the same furrows and lozenges as the skin, and has the same openings and pores; and though it may be said to pass the bounds of the skin, where it is continued inward, through the great openings, yet at these places it loses the name of epidermis.

When we examine narrowly the small pores or holes, through which the sweat passes, the epidermis seems to enter these, in order to complete the excretory tubes of the cutaneous glands. The fossulæ of the hairs have likewise the same productions of the epidermis, and it seems to give a sort of coat or bark to the hairs themselves. Lastly, the almost imperceptible ducts of the cutaneous pores are lined by it.

### USES OF THE SKIN.

It is chiefly and properly the filamentary substance, called the body of the skin, which is the universal integument of the body, and the basis of all the other cutaneous parts; each of which has its particular uses.

The skin is able to resist external injuries to a certain degree, and such impressions, frictions, strokes, &c. to which the human body is often liable, as would hurt, wound, and disorder the parts of which it is composed, if they were not defended by the skin.

The papillæ are the organ of feeling, and contribute to an universal evacuation, called insensible transpiration. They likewise serve to transmit from without, inwards, the subtle particles or impressions of some things applied to the skin. The first of these three uses depends on the extremities of the nerves, the second on the arterial productions, and the third on the productions of the veins.

The cutaneous glands secrete an oily humour of different consistences, and they are likewise the origin of sweat.

The epidermis serves to keep the pencils or nervous filaments of the papillæ in an even situation, and without confusion; and is likewise moderates the impressions of external objects.

Another use of the epidermis is to regulate the cutaneous evacuations already mentioned, the most considerable of which is insensible transpiration.

### THE MEMBRANA ADIPOSA, AND FAT.

The second universal integument of the human body,

is the *membrana adiposa*, or *corpus adiposum*. This is not, however, a single membrane, but a congeries of a great number of membranous laminae, joined irregularly to each other at different distances, so as to form numerous interstices of different capacities, which communicate with each other. These interstices have been named *cellulae*, and the substance made up of them, the *cellulous substance*.

The thickness of the *membrana adiposa* is not the same all over the body, and depends on the number of laminae of which it is made up. It adheres very closely to the skin, runs in between the muscles in general, and between their several fibres in particular, and communicates with the membrane which lines the inside of the thorax and abdomen.

The structure is demonstrated every day by butchers, in blowing up their meat, when newly killed; in doing which, they not only swell the *membrana adiposa*, but the air insinuates itself likewise in the interstices of the muscles, and penetrates even to the viscera, producing a kind of artificial emphysema.

These cellular interstices are so many little bags or satchels, filled with an unctuous or oily juice, more or less liquid, which is called *fat*.

This substance increases in quantity in the body, by rest and good living; and on the contrary, diminishes by hard labour and a spare diet.

The proportional differences in the thickness of this *membrana adiposa*, are determined, and may be observed to be regular in some parts of the body, where either beauty or use required it.

Thus we find it in great quantities, where the interstices of the muscles would otherwise have left disagreeable hollow or void places; but being filled, and as it were padded with fat, the skin is raised, and an agreeable form given to the part.

In some parts of the body the fat serves for a cushion, pillow, or mattress; as on the buttocks, where the laminae and cells are very numerous.

The fat is likewise of great use to the muscles, in preserving the flexibility necessary for their actions, and in preventing or lessening their mutual frictions.

## THE NAILS.

The substance of the nails is like that of horn, and they are composed of several planes of longitudinal fibres soldered together. These strata end at the extremity of each finger, and are all nearly of an equal thickness, but of different lengths.

The external plane or stratum is the longest, and the rest decrease gradually, the innermost being the shortest; so that the nail increases in thickness from its union with the epidermis, where it is thinnest, to the end of the finger, where it is thickest.

The graduated extremities or roots of all the fibres of which these planes consist, are hollowed for the reception of the same number of very small oblique papillae, which are continuations of the true skin, which having reached to the root of the nail, forms a semilunar fold, in which that root is lodged.

After this semilunar fold, the skin is continued on the whole inner surface of the nail. The fold of the skin is accompanied by the epidermis, to the root of the nail exteriorly, to which it adheres very closely.

Three parts are generally distinguished in the nail, the root, body, and extremity. The root is white and in form of a crescent; and the greatest part of it is hid under the semilunar fold already mentioned.

The crescent and the fold lie in contrary directions to each other. The body of the nail is naturally arched, transparent, and appears of the colour of the cutaneous papillae which lie under it.

The principal use of the nails is to strengthen the ends of the fingers and toes, and to hinder them from being inverted towards the convex side of the hand or foot, when we handle or press upon any thing hard.

## THE HAIRS.

The hairs belong as much to the integuments as the nails. They are a kind of reeds or rushes, the roots or bulbs of which lie toward that side of the skin which is next the *membrana adiposa*. The trunk or beginning of the stem perforates the skin, and the rest of the stem advances beyond the outer surface of the skin, to a certain distance, which is very various in the different parts of the body.

When the different hairs are examined by a microscope, we find the roots more or less oval, the largest extremity being either turned toward, or fixed in the *corpus adiposum*.

This oval root is covered by a whitish strong membrane; in some measure elastic; and it is connected either to the skin, to the *corpus adiposum*, or to both, by a great number of very fine vessels and nervous filaments.

Within the root, we observe a kind of glue, some very fine filaments of which advance toward the small extremity, where they unite and form the stem, which passes through this small extremity to the skin. As the stem passes through the root, the outer membrane is elongated in form of a tube, which closely invests the stem, and is entirely united to it.

The stem having reached the surface of the skin, pierces the bottom of a small fossula between the papillae, or sometimes a particular papilla, and there it meets the epidermis, which seems to be inverted round it, and to unite with it entirely. A sort of unctuous matter transudes through the sides of the fossula, which is bestowed on the stem, and accompanies it, more or less, as it runs out from the skin, in form of an hair.

## SECT. II. Of the ABDOMEN.

The Abdomen begins immediately under the thorax, and terminates at the bottom of the pelvis of the *ossa innominata*. Its circumference, or outer surface, is divided into regions, of which there are three anterior, viz. the epigastric or superior region, the umbilical or middle region, and the hypogastric or lower region. There is but one posterior region, named *regio lumbaris*.

The

The epigastric region begins immediately under the appendix ensiformis, at a small superficial depression, called the pit of the stomach, and ends above the navel at a transverse line, supposed to be drawn between the last false ribs on each side.

This region is subdivided into three parts; one middle, named epigastrium; and two lateral, termed hypochondria. The epigastrium takes in all that space which lies between the false ribs of both sides, and the hypochondria are the places covered by the false ribs.

The umbilical region begins above the navel, at the transverse line already mentioned, and ends below the navel at another transverse line, supposed to be drawn parallel to the former, between the two crista of the os ilium.

This region is likewise divided into three parts; one middle, which is properly the regio umbilicalis; and two lateral, called ilia, or the flanks; and they comprehend the space between the false ribs and upper part of the os ilium on each side.

The hypogastric region is extended downward from the inferior limit of the umbilical region, and is divided into three parts; one middle, called pubis; and two lateral, called inguina, or the groins.

The lumbar region is the posterior part of the abdomen, and comprehends all that space which reaches from the lowest ribs on each side, and the last vertebra of the back, to the os sacrum and neighbouring parts of the os ilium. The lateral parts of this region are termed the loins, but the middle part has no proper name in men.

Lastly, the bottom of the abdomen, which answers to the pelvis of the skeleton, is terminated anteriorly by the pudenda or parts of generation, and posteriorly by the clunes and anus. The buttocks are separated by a fossa, which leads to the anus; and each buttock is terminated downward by a large fold, which distinguishes it from the rest of the thigh.

The space between the anus and the parts of generation, is called perinæum, and is divided into two equal lateral parts by a very distinct line, which is longer in males than in females.

The cavity of the abdomen, formed by the parts already mentioned, (all which are covered by the skin and membrana adiposa) is lined on the inside by a particular membrane, called peritonæum. It is separated from the cavity of the thorax by the diaphragm, and terminated below by the muscoli levatores ani.

This cavity contains the stomach, and the intestines. It contains likewise the mesentery, mesocolon, omentum, liver, gall bladder, spleen, pancreas, glands of the mesentery, vasa lactea, receptaculum chyli, kidneys, renal glands, ureters, bladder, and the internal parts of generation in both sexes.

The whole fore-part of the abdomen forms an oblong convexity, like an oval vault, more or less prominent in the natural state, in proportion to the quantity of fat upon it, and of food contained in it, or to the different degrees of pregnancy in women. The hypogastric and umbilical regions are more subject to these varieties, than the epigastric region.

The appendix ensiformis of the sternum, the cartilaginous portions of the last pair of true ribs, those of the first four pairs of false ribs, all the fifth pair, the five lumbar vertebrae, the ossa innominata, the os sacrum; and os coccygis, form the bony sides of the cavity of the abdomen.

The diaphragm, the muscles called particularly muscoli abdominis, the quadrati lumborum, psoai, iliaci, the muscles of the coccyx, and of the intestinum rectum, form the chief part of the circumference of this cavity.

The cavity of the abdomen is of an irregularly oval figure, but still symmetrical. On the fore-side it is uniformly arched or oval, and its greatest capacity is even with the navel, and nearest part of the hypogastrium. On the upper side it is bounded by a portion of a vault, very much inclined. On the back-side, it is in a manner divided into two cavities by the jutting out of the vertebrae of the loins. On the lower side, it contracts gradually all the way to the little edge of the pelvis, and from thence expands again a little as far as the os coccygis and tubercles of the ischium, terminating in the void space between these three parts.

### PERITONÆUM.

HAVING carefully removed the muscles of the abdomen, the first thing we discover is the peritonæum, a membranous covering, which adheres immediately to the inner surface of the muscoli transversi, and of all the other parts of this cavity; and involves and invests all the viscera contained therein, as in a kind of bag.

The peritonæum in general is a membrane of a pretty close texture, and yet very limber, and capable of a very great extension; after which it can recover itself, and be contracted to its ordinary size; as we see in pregnancy, dropsies, corpulency, and repletion.

It seems to be made up at least of two portions, one internal, the other external; which have been looked upon by many anatomists as a duplicature of two distinct membranous laminae. But, properly speaking, the internal portion alone deserves the name of a membranous lamina, as being the main body of the peritonæum. The external portion is no more than a kind of fibrous or follicular apophysis of the internal; and may properly enough be termed the cellular substance of the peritonæum.

The true membranous lamina, commonly called the internal lamina, is very smooth, and polished on that side which is turned to the cavity and viscera of the abdomen, and continually moistened by a serous fluid discharged through almost imperceptible pores.

The cellular substance, or external portion of the peritonæum, adheres very closely to the parts which form the insides of the cavity of the abdomen.

The cellular substance has several elongations, which have been called productions of the peritonæum. Two of these productions accompany and invest the spermatic ropes in males, and the vascular ropes, commonly called the round ligaments, in women. There are other two, which pass under the ligamentum Fallopii, with the

crural vessels, which they involve, and are gradually lost in their course downward.

To these four productions of the cellular substance of the peritonæum, we may add a fifth, which is spread on the neck of the bladder, and perhaps a sixth, which accompanies the intestinum rectum. All these elongations pass out of the cavity of the abdomen, and may be termed external, to distinguish them from others that remain in the abdomen, and are called internal, of which hereafter.

The great blood-vessels, that is, the aorta and vena cava, are likewise involved in this cellular substance of the peritonæum. In a word, it involves immediately and separately all the parts and organs which are commonly said to lie in the duplicature of the peritonæum.

It has, nevertheless, productions of its own, but they are very different from those of the cellular substance; for they run from without, inward, that is, they advance from the convex side of the great bag of the peritonæum, into the cavity of that bag, some more, some less, and also in different manners; as if the sides of a large ball or bladder were thrust inward into the cavity of the ball or bladder.

Of these internal elongations or intropressions of the true lamina of the peritonæum, some are simply folded, like a duplicature; some are expanded like inverted bags or sacculi to contain some viscus; some begin by a simple duplicature, and are afterwards expanded into a cavity, which contains some organ; some are alternately extended in the form of simple duplicatures, and of cavities; and lastly, some form only a small eminence on the inner surface of the great cavity of the peritonæum.

The chief uses of the peritonæum are, to line the cavity of the abdomen, to invest the viscera contained in that cavity as in a common bag, to supply them with particular coats, to form productions, ligaments, connexions, folds, vaginæ, &c.

The fine fluid which transudes through the whole internal surface of the peritonæum, prevents the inconveniences which might arise from the continual frictions and motions to which the viscera of the abdomen are exposed either naturally or by external impulses.

## VENTRICULUS, OR STOMACH.

The stomach is a great bag or reservoir, situated partly in the left hypochondrium, and partly in the epigastrium.

The figure of the stomach is like that of a bag-pipe, oblong, incurvated, large and capacious at one end, and small and contracted at the other.

The curvature of the stomach gives us occasion to distinguish two arches in it; one large, which runs along the greatest convexity; and one small, directly opposite to the former. The sides of the stomach, are the two lateral portions which lie between the two arches.

The stomach has two extremities, one large, and one small like a crooked funnel. It has two openings, called the orifices of the stomach, one between the great extremity and the small curvature, the other at the end of the small or contracted extremity. The first opening

is a continuation of the œsophagus; the other joins the intestinal canal, and is called pylorus.

The great extremity of the stomach is in the left hypochondrium, and for the most part immediately under the diaphragm.

The small extremity of the stomach does not reach to the right hypochondrium. It bends obliquely backward toward the upper orifice, so that the pylorus lies about two fingers breadth from the body of the vertebræ immediately under the small portion of the liver, and consequently lower down, and more forward than the other orifice by almost the same distance.

According to this natural situation, the stomach, especially when full, lies so as that the great curvature is turned more upward than downward, and the small curvature more backward than upward.

One of the lateral convex sides is turned upward, the other downward; and not forward and backward, as they appear in dead bodies, where the intestines do not support them in their natural situation.

The stomach is composed of several parts, the chief of which are the different strata which form its substance, to which anatomists give the name of tunice or coats. These coats are commonly reckoned to be four in number, the outer or common, the fleshy or muscular, the nervous or aponeurotic, and the villous or inner coat; and they are afterwards subdivided several ways.

The first or outermost coat is simply membranous, being one of the internal productions of the peritonæum.

The second or muscular coat is made up of several planes of fibres, which may all be reduced to two, one external, the other internal. The external coat is longitudinal, though in different respects, following nearly the direction of the curvatures and convexities of the stomach; and the internal plane is transversely circular.

Between the outer and inner planes, round the superior orifice, there are two distinct planes, about the breadth of a finger, and very oblique, which surround this orifice in opposite directions, and intersect each other where they meet on the two lateral sides.

Along the middle of each lateral side of the small extremity, there runs a tendinous or ligamentary flat portion, above a quarter of an inch in breadth, which terminates in the pylorus. These two portions lie between the common and muscular coats, and adhere very strongly to the first.

Between the same two coats, there is a cellular substance which adheres very closely to the external coat, and insinuates itself between the fleshy fibres of the second, all the way to the third.

The third coat, called commonly tunica nervosa, sustains, on its convex side, a very large reticular distribution of capillary vessels and nerves. On the concave side, it seems to be of a very loose texture, and as it were spongy or filamentary, containing a great number of small glandular bodies, especially near the small curvature and small extremity of the stomach.

The fourth coat of the stomach is termed villosa, because, when it swims in clear water, some have imagined they saw something in it like the pile of velvet.

These two coats are of a larger extent than the two former,

former, and they join in forming large rugæ on the concave surface of the stomach, the greatest part of which are transverse, though irregular and waving.

In the interstices of these rugæ, there is often found a sort of slimy mucus, with which the whole cavity of the stomach seems likewise to be moistened. This mucus is much more fluid in living bodies, and is supplied by the glands of the stomach. It is termed *succus gastricus* or *stomachicus*.

On the inner surface of the small extremity of the stomach, at the place where it ends in the intestinal canal, we observe a broad, thin, circular border, with a roundish hole in the middle. This hole is the inferior orifice of the stomach, called by the Greeks *pylorus*, which signifies a porter.

This border is a fold or duplicature of the two inner coats of the stomach, the *nervosa* and *villosa*; and it is formed in part by a fasciculus of fleshy fibres fixed in the duplicature of the *tunica nervosa*; and distinguished not only from the other fleshy fibres of the extremity of the stomach, but also from those of the intestines, by a thin, whitish circle, which appears even through the external or common coat, round the union of the stomach and intestines.

The figure of the pylorus is that of a ring, transversely flattened, the inner edge of which, or that next the center, is turned obliquely toward the intestines, like a broad portion of a funnel. This inner edge runs naturally more or less into little plaits or gathers, like the mouth of a purse almost shut. It is therefore a kind of sphincter, which can contract the inferior orifice of the stomach, but seems not capable of shutting it quite close.

The stomach receives in general whatever the mouth sends thither, through the canal of the œsophagus; but its particular use is to receive the aliments, to contain them for a longer or shorter time, in proportion as they are more solid or fluid, and to digest them, that is, to put them in a condition to be turned into that nutritious fluid called chyle.

This operation, which goes by the general name of digestion, and by which chyliification begins, is performed partly by the *succus gastricus*, which flows continually from the *tunica villosa*, and partly by the continual contraction and relaxation of the muscular coat.

The pylorus, or fleshy circle of the inferior orifice of the stomach, serves to retain the aliments in it, till they have acquired a sufficient degree of fluidity to pass easily through that opening.

The gentle and alternate motions of the orbicular fibres of the muscular coat, may assist in sending through the pylorus, in the natural way, the aliment that is sufficiently digested. This was called the peristaltic or vermicular motion, by those who believed that it is successively reiterated, like that of earth-worms when they creep.

The situation of the stomach, which is nearly transverse, is likewise of use in making the aliment remain long enough in that cavity, and may serve to make the length of this stay in some measure arbitrary, by means of the different postures of the body; for when we lie on the left side, the aliment must remain longer, than when we lie on the right, &c.

*The INTESTINES in general, and Intestinum Duodenum in particular.*

BETWEEN the pylorus and the very lowest part of the abdomen, lies a long canal, bent in a great many different directions, by numerous convolutions or turnings, called the intestines.

This canal, thus folded and turned, forms a considerable bulk, which fills the greatest part of the cavity of the abdomen; and it is connected, through its whole extent, to membranous productions or continuations of the peritonæum, principally to those called the mesentery and mesocolon.

The incurvations of the intestinal canal form two arches, a small one by which it is connected to the mesentery and mesocolon, and a great one on the opposite side, which lies loose. The whole canal is generally about seven or eight times as long as the body.

The intestines in general are composed of several coats, much in the same manner with the stomach. The first and outermost is a continuation of the mesentery, or of some other elongation, or duplicature of the peritonæum.

This is commonly termed the common coat; and it has a cellular substance on its inner surface, like that of the stomach.

The second coat of the intestines is fleshy or muscular, and made up of two planes, one external, the other internal. The external plane is very thin, and its fibres longitudinal; the internal plane is thicker, and its fibres run transversely round the circumference of the intestinal cylinder.

The third coat is called *nervosa*, and is something like that of the stomach. It has a particular plane, which serves as a basis to sustain it, made up of very fine, strong, oblique fibres, which seem to be of the ligamentary or tendinous kind.

This coat sustains two reticular substances which are both vascular, one arterial, the other venal, accompanied by a great number of nervous filaments. These vessels and nerves are productions of the mesenteric vessels and nerves; and as they surround the whole canal of the intestines, some anatomists have formed them into a distinct coat, by the name of *tunica vasculosa*.

The nervous coat sends off from its inner surface a great number of portions of septa, more or less circular, which contribute to the formation of what are called *valvulæ conniventes*.

The fourth or innermost coat is very soft, and is named *tunica villosa*. It has the same extent with the third coat, which supports it, and it lines all the septa of that third coat.

The small intestines form one continued uniform canal; and though three portions of it have three different names, yet we have no sufficient marks whereby to distinguish them, to fix the precise extent or length of each portion, to settle its just limits.

The first and shortest portion of the whole canal, is called duodenum; the second, which is much longer, jejunum; and the third, which is still longer than the second, ileum.

The duodenum having arisen from the pylorus, is immediately bent a little backward, and obliquely downward; then it bends a second time toward the right kidney, to which it is a little connected, and from thence passes before the renal artery and vein, ascending insensibly from right to left, till it gets before the aorta and last vertebræ of the back. It continues its course obliquely forward, by a gentle turn.

Through this whole course, the duodenum is firmly bound down by folds of the peritonæum, especially by a transverse duplicature which gives origin to the mesocolon.

The villi of this intestine are thicker than in the stomach; but the texture of them in man is not like hairs, as they are commonly represented in figures; but rather like that of a fungous granulated substance, composed of an infinite number of very fine papillæ of different figures, in which we see, through a microscope, a multitude of depressed points or pores, by which their whole surface seems to be pierced.

By the same help we observe, on different places of the inner surface of this intestine, several round villous tubercles, rising like small verrucæ at different distances from each other.

This substance sustains an infinite number of capillary vessels, of different kinds; for besides the blood-vessels, we sometimes observe a great number of white filaments which run through it, and end at its inner surface, like so many capillary roots of the vessels, called *venæ lacteæ*.

The internal surface of the duodenum is furnished with a great number of small flat glandular tubercles, raised on the sides, and depressed in the middle, by a kind of fossula; and they are more numerous near the beginning of this intestine than any where else.

These glands appear like little bladders, with the orifices turned toward the cavity of the intestine, and the bodies fixed in the spongy substance next the nervous coat. They furnish a particular viscid fluid.

In the inner surface of the duodenum, almost at the lower part of the first incurvation, and on the shortest side, there is a longitudinal eminence, in the point or apex of which lies a particular opening, which is the orifice of the ductus biliaris, within which the ductus pancreaticus likewise opens.

### INTESTINUM JEJUNUM.

THE jejunum, so called, because it is oftener found empty than the ilium, begins at the last incurvation of the duodenum, and is there connected to the beginning of the mesocolon.

From thence it bends downward from left to right, and obliquely forward, or from the vertebræ, and makes several convolutions, which lie chiefly in the upper part of the umbilical region. Through all this course it is connected to the mesentery.

The jejunum and ilium may be distinguished by dividing both intestines into five parts; and to allow nearly two fifths to the jejunum, and three fifths and a little more to the ilium.

The coats of the jejunum are nearly of the same structure with those of the duodenum, but thinner.

### INTESTINUM ILEUM.

THE convolutions of the intestinum ileum surround those of the jejunum on the two lateral and lower sides, and it passes in a winding course from the left side, by the hypogastrium, to the right side, where it terminates a little below the right kidney, joining the *intestina crassa*.

The structure of the ileum is much the same with that of the jejunum; only the internal duplicatures or *valvulæ conniventes* decrease gradually both in number and size.

#### *The INTESTINA CRASSA in general, and Intestinum cæcum in particular.*

THE great intestines are one continued canal, divided into three portions, like the small ones. This canal begins by a kind of sacculus or bag, which is reckoned the first of the three portions, and called *cæcum*. The second portion, called colon, is the longest of the three, and is distinguished from them by a great number of particular eminences or convexities, which appear on its outer surface through its whole length. The last portion is named *rectum*, being more uniform, narrower, thicker, and much shorter than the colon.

The structure of the great intestines is nearly the same with that of the small ones, in regard both to the number and disposition of their coats. They are shorter, and have fewer convolutions, but are much more capacious. The coats in general are stronger, but especially the muscular coat.

The *intestinum cæcum* is only a round short broad bag, the bottom of which is turned downward, and the mouth or opening upward. It lies under the right kidney, and is hid by the last convolution of the ileum. It is about three fingers breadth in length, and its diameter is more than double that of the small intestines.

On one side of the bottom of the *cæcum* lies an appendix, resembling a small intestine, nearly of the same length with the *cæcum*, but very slender. It is termed *appendicula vermiformis*, from its supposed resemblance to an earth-worm. Its common diameter is not above a quarter of an inch. By one extremity it opens laterally, and a little obliquely, into the bottom of the *cæcum*; and the other extremity is closed, being sometimes greater, sometimes smaller, than the rest of the appendix.

Through the membranous or common coat of the *cæcum*, we see three white ligamentary bands, which adhere very closely both to the outer and muscular coat. One of them is hid by the adhesion of the mesocolon; and all the three divide the *cæcum* longitudinally into three parts more or less equal.

They all unite in the *appendicula vermiformis*, and cover its whole outer side immediately under the common coat.

INTE-



## INTESTINUM COLON.

THE colon is the most considerable of all the intestines. From the cæcum, of which it is a continuation, it reaches, in form of an arch, above the umbilical region, and to the lower part of the left hypochondrium. Its continuity is however a little interrupted by the ileum, which advances into the cavity of the colon, and, together with a certain fold of that intestine, forms what is called *valvula coli*.

The whole convex side of the colon is divided longitudinally into three parts, by three ligamentary bands, continued from those of the cæcum, and of the same structure with these. Two of the three bands run on each side, along the great curvature of the colon; and the third along the small curvature.

These three longitudinal bands do the office of *fræna*, between which this intestine is through its whole length alternately depressed into transverse folds, and raised into considerable eminences. All the folds are duplicatures, which form portions of *valvulæ conniventes* in the cavity of the intestine; and the eminences form receptacles, called the cells of the colon.

The common coat, on one side, is a continuation of the mesocolon; and, on the other side, it contributes, by the same continuation, to form the omentum.

The arch of the colon begins under the right kidney, near the haunch. It runs up on the fore side of that kidney to which it is connected, passes under the *vesicula fellis*, which tinges it with a yellow colour at that place, and continues its course before the first incurvation of the duodenum, to which it adheres, and partly hides it. In this part of its course, therefore, there is a remarkable connexion between the colon, duodenum, right kidney, and *vesicula fellis*.

From thence the arch of the colon runs before the great convexity of the stomach, and sometimes a little lower; then turns backward under the spleen, in the left hypochondrium; runs down on the fore side of the left kidney, to which it is connected; below this kidney turns toward the vertebræ, and terminates there by a double incurvation, or by two opposite convolutions, which represent in some measure an inverted roman S.

At the place where the cæcum joins the colon, one portion of the circumference of both is depressed, and forms a large fold on the inside, which advances into the cavity of the intestine. It is a little open in the middle, and its extremities are very thick, by reason of the mutual duplicature of the coats of the cæcum and colon.

The extremity of the ileum is as it were grafted in the opening of this fold, and strongly united to its sides by the adhesion of its transverse fibres to the transverse fibres of the cæcum and colon.

This union forms a pretty thick ring, which likewise advances into the common cavity of the cæcum and colon, where it is wrinkled or formed into gathers, almost like the lower extremity of the œsophagus, the pylorus or inside of the anus. Its circumference is more or less oval; and, by a kind of continuity with the com-

mon fold of the cæcum and colon, it forms two productions, which *M. Morgagni* calls the *fræna* of the *valvula coli*.

The membranous coat of the extremity of the ileum is continued on the cæcum and colon, without sinking into any fold, at the place where the ileum enters the colon.

This *valvula coli* is contrived to hinder the return of the excrements into the ileum; it produces this effect partly as a valve, and partly as a kind of sphincter.

The capacious arch of the colon is contracted by both extremities to the regio lumbaris, near the kidneys, by two particular ligaments, one on the right side, the other on the left, which are only small duplicatures of the peritonæum, more or less transverse.

The remaining portion, which forms the two convolutions in form of the roman S, contracts below the left kidney, being narrower there, than lower down. The coats of this portion become gradually thicker and stronger, and likewise the ligamentary bands, which approach each other by degrees, and seem to increase in breadth.

## INTESTINUM RECTUM AND ANUS.

THE last of all the intestines, is named rectum, or the straight gut, which, properly speaking, is a true continuation of the last convolution of the colon; and it is the repository, sink, and common sewer, of the whole intestinal canal.

The rectum having passed below the last vertebra of the loins, to the inside of the os sacrum, is bent backward on that concave side to which it is connected; and having reached the os coccygis, it runs likewise in the direction of that bone, and bends a little forward, terminating beyond the extremity of the coccyx.

The figure of this intestine varies according as it is full or empty. When empty, it is irregularly cylindrical, and sinks in by a kind of transverse folds; and in that state, it is about three fingers breadth in diameter, more or less. When full, it is wider in proportion to the quantity of fæces, wind, or whatever else is contained in it; and it may be extended to the size of a large bladder, so as to represent a kind of stomach.

The membranous coat often contains a great quantity of fat, spread between it and the muscular coat, and forming round the intestine numerous eminences, in the room of the *appendices adiposæ* of the colon.

The muscular or fleshy coat is very thick: the longitudinal fibres, which in the other intestines are very thin, are in this stronger than the circular fibres of the rest. The ligamentary bands continue to increase in breadth, and to approach each other.

The nervous or filamentous and internal coats, are larger here, than in the other intestines; and when the rectum is empty, they form a great number of waving rugæ in its cavity, which disappear, in proportion as that cavity is filled.

The innermost coat is very improperly termed *villosa*, and scarce deserves the name of *papillaris*, because of the smallness of the little corpuscles spread on its surface.

It contains a great number of singl or solitary glands; and it is always moistened by a mucus of different consistences discharged by these glands or folliculi.

Near the extremity of this intestine, the rugæ or folds become in a manner longitudinal; and at last, towards the circumference of the inner margin of the anus, they form little bags or semilunar lacunæ, the openings of which are turned upward, toward the cavity of the intestine. These lacunæ are something like those at the lower extremity of the œsophagus, or upper orifice of the stomach.

At length the extremity of the rectum contracts, and terminates by a narrow orifice called the anus, the sides of which are disposed in close folds or gathers. This extremity of the intestine has several muscles belonging to it, some of which surround it like sphincters, the rest are broad fleshy planes inserted in it, and which being likewise fixed to other parts, sustain it in its natural situation, and restore it to that situation when disturbed by the force necessary for the exclusion of the fæces. These latter muscles are termed levatores ani, the first go by the general name of sphincters.

These sphincters are three in number, one intestinal or orbicular, and two cutaneous or oval; whereof one is large, superior, and internal; the other small, inferior, and external.

The intestinal or orbicular sphincter of the anus, consists merely in an augmentation of the inferior portion of the fleshy fibres of the extremity of the rectum.

The cutaneous ligament goes out anteriorly, from the extremity of the os coccygis. It is very slender, and divides into two portions at the orifice of the anus, which run into the membrana adiposa, and are inserted in the skin on each side of the anus, by a kind of expansion; and continuing to divaricate, they are lost on the two sides of the peritonæum.

The interosseous ligament of the ossa pubis is a very strong triangular membrane, fixed by two of its edges in the inferior rami of these bones, all the way up to their common symphysis. The third edge, which is the lowest, is loose; and this whole membrane, the middle of which is perforated by a particular hole, is stretched very tight between the two bones, and under their cartilaginous arch, to which it adheres very closely.

At the lower part of this interosseous ligament, along its whole lower or loose edge, lies a digastric muscle, fixed by its two extremities in the rami of the ossa pubis, its middle tendon lying on the middle of the edge of the ligament.

The cutaneous sphincters have each an anterior and posterior insertion, ending both ways in a kind of point, and comprehending the orifice of the anus between their middle portions.

They are distinguished from each other by their situation, by their size, and by a kind of white cellular line. The greatest of the two appears to be double, and the smallest lies nearest the skin, and adheres most closely to it.

They are inserted backward, partly in the apex of the os coccygis, and partly in the contiguous portion of the cutaneous ligament of that bone. Forward their chief

insertion is in the middle tendon of the transversalis urethræ; and they have likewise some connexions to other muscles of the urethra.

The levatores ani are broad, thin, muscular portions, fixed by one extremity of their fleshy fibres round the concave side of the inferior portion of the pelvis, from the symphysis of the ossa pubis, beyond the spine of the ischium. The other extremity of these fibres runs down on each side behind, and under the curvature of the end of the rectum, where they meet together, and unite from the basis of the os coccygis all the way to the margin of the anus.

We ought likewise to remark, that the margin or edge of the anus is formed by the union of the skin and epidermis with the internal coat of the rectum; so that the most superficial portion of that coat seems to be a continuation of the epidermis.

### MESENTERIUM & MESOCOLON.

THIS great bundle of intestines is not left to move at random in the cavity of the abdomen; but artfully bound down by a membranous web, which prevents the intestinal convolutions from being intangled in each other, and from being twisted or compressed in all their different ways of meeting; and yet allows them a gentle floating, but limited motion.

This web is distinguished into two portions; one of which, being very broad and very much plaited, connects the small intestines; the other, which is long and incurvated, does the same office to the greater intestines.

These two portions are in reality only one and the same continuation of the membranous lamina of the peritonæum doubled back upon itself, and they are distinguished only by their breadth. Taken both together, they form a kind of spiral roll, more or less plaited in its circumference. The first portion has retained the name of *mesentery*, the other is termed *mesocolon*.

The mesentery begins at the last incurvation of the duodenum, and runs obliquely from left to right, along the vertebræ of the loins. In this space, the membranous portion of the peritonæum is detached on both hands, produces a duplicature by two elongations or particular laminæ applied to each other, and thus forms the mesentery.

It is narrow at its upper and lower parts, but chiefly at the upper. The middle portion is very broad, and the edge of it next the intestines is every where very much plaited. These plaits or folds are only waving inflexions, such as may be observed in the edge of a piece of shamoy, which has been often drawn through the fingers. They make this edge of the mesentery very long, and they run through about one third of its breadth.

The two laminæ are joined together by a cellular substance, which contains glands, vessels, and nerves; and in some subjects a great quantity of fat, which keeps the two laminæ a distance from each other.

Along the whole circumference of the mesentery, the two laminæ are naturally separated, and applied to the two sides of the small intestines, which they invest by their union, or rather reciprocal continuation on the great curvature

curvature of that canal, and carry it as in a scarf or sling. This is what forms the external or membranous coat of the intestines.

The mesocolon is the continuation of the mesentery, which having reached the extremity of the ilium, contracts and changes its name. At this place the particular lamina which is turned to the right side, forms a small transverse fold, called *ligamentum coli dextrum*.

Afterwards the mesocolon ascends towards the right kidney, where it seems to be lost by the immediate adhesion of the colon to that kidney, and to the first incurvation of the duodenum. Then it appears again, and, increasing in breadth, it continues its course almost transversely under the liver, stomach, and spleen, where it begins to turn downward, under the left hypochondrium, toward the kidney on the same side.

Through this whole course, the mesocolon extends in breadth, and forms nearly a transverse semicircular plane, very little plaited at its great circumference. By this circumference or edge, it is connected to the colon; and hides that ligamentary band of this intestine, which runs along its small curvature. By its short or small edge, it forms the triangular case of the duodenum; and by its great edge, the external coat of the colon, in the same manner as the mesentery does that of the small intestines. As it passes under the large extremity of the stomach, it adheres a little to the lower portion of that extremity, as the diaphragm does to the upper.

Having got below the left kidney, it contracts and forms another transverse fold, called *ligamentum coli sinistrum*. Afterwards it expands again, but not so much as in the upper part, and runs down on the left psoas muscle, toward the last vertebra of the loins. This descending portion is fixed to the convolutions of the colon in the same manner as the superior portion is to the arch of that intestine.

The *intestinum rectum* is likewise invested by a particular production of the peritonæum, called commonly by the barbarous name of *mesorectum*. This production is very narrow; and, about the middle of the foreside of the rectum, it forms a transverse semicircular fold, which appears when the intestine is empty, but is lost when it is filled.

#### GLANDULÆ MESENTERICÆ, VASA LYMPHATICA & LACTEA.

BETWEEN the lamina of the mesentery, a great number of glands lie scattered through the cellular substance. In the natural state, these glands are something of the figure of lentils or little round beans; some of them being cubical, others oval, but all of them a little flattened.

These glands are of the number of those that anatomists call *glandulæ conglobatæ*, the structure of which is not as yet sufficiently known. They seem to be of a cellular substance, surrounded by a very fine membrane or coat, on which, by the help of microscopes, we discover an intertexture of particular filaments.

Besides the blood-vessels which are distributed in a reticular manner in the mesenteric glands, and besides many nervous filaments spread through them, we dis-

cover an infinite number of small vessels of another kind running from gland to gland.

These vessels are extremely thin and transparent, and furnished on the inside with numerous valves, which appear on the outside like little small knots very near each other. They go out from each gland by ramifications, as by so many roots, and having formed a small trunk, they are again divided, and enter some neighbouring gland by the same kind of ramifications by which they went out from the former.

They are termed *lymphatic vessels*, because for the most part they contain a very clear, limpid, though mucilaginous serum, called *lymphæ* by anatomists. But as they have likewise been observed to be filled with a white milky fluid, called *chyle*, they have been called *vasa chylosifera*, or *vena lactea*. They have the name of *veins*, because their valves are disposed as those of the ordinary blood-veins, and because the fluid which they contain runs from smaller into larger tubes.

They derive their first origin from the tunica villosa of the intestines, and chiefly from that of the small intestines, by a great number of small capillary roots. From these roots there arises, between the coats of the intestines, a kind of rete mirabile, which surrounds almost the whole circumference of the intestinal canal, between the muscular and external coat.

This reticular texture of lacteal vessels keeps close to the external coat, and leaves the canal along with it, on the side of the mesentery, where it forms two planes of ramifications, plainly distinguished from each other by the cellular substance, and adhering closely to the inside of the two membranes of the mesentery. In this separate state they run on the lamina of the mesentery, as far as the first mesenteric glands, where they unite again into one plane.

After this union, the lacteal vessels are distributed almost uniformly through the whole extent of the mesentery, from its circumference to its origin or adhesion to the vertebra of the back, between the mesenteric glands, which they join, and form frequent anastomoses or communications.

Having passed through the mesentery, the ramifications begin to unite as they approach the spina dorsa, and consequently their number is lessened, and their size increased; and having passed the last mesenteric glands, they terminate about the middle of the adhesion of the mesocolon in small common trunks, which receive a great number of lymphatic vessels from the glandulæ lumbares, and others below these.

The lacteal vessels which lie between the mesenteric glands and middle adhesion of the mesocolon to the spina dorsa, run down on the body of the inferior aorta, between the extremities of the small muscle of the diaphragm, and terminate in a kind of cistern, called by some *receptaculum chyli*, by others *receptaculum Pecquetii*.

The greatest part of the receptaculum chyli lies behind the right portion of the inferior muscle of the diaphragm, on the right side of the aorta, at the union of the last vertebra of the back with the first of the loins. It is a kind of membranous vesicle, the conformation of which is various in human subjects. Sometimes it is of

an uniform long oval figure, like the vesicula fellis; sometimes it is divided by strictures, into several small roundish bags more or less flattened, and sometimes it surrounds the trunk of the aorta like a collar.

It is composed of very thin coats, and its cavity is divided by small pelliculæ or membranous septa, the disposition of which is irregular. It is chiefly round the lower part of this receptacle, that the last lacteal vessels are inserted, some on the sides, and some behind the aorta; and they are accompanied by numerous lymphatic vessels. The upper portion is contracted between the aorta and vena azygos, and forms a particular canal, which runs up through the thorax, by the name of *ductus thoracicus*.

### HEPAR & VESICULA FELLIS.

THE liver is a large and pretty solid mass, of a dark red colour, a little inclined to yellow, situated immediately under the arch of the diaphragm, partly in the right hypochondrium, which it fills almost entirely, and partly in the epigastrium, between the appendix ensiformis and spina dorsi, and terminating commonly in the left hypochondrium.

The figure of the liver is irregular, it being arched or convex on the upper part, unequally concave on the lower, and very thick on the right and back sides. Towards the left and anterior sides its thickness decreases very much, and terminates there by a kind of edge; and it is broader from right to left, than from before backwards.

It may be divided into lateral parts called *lobes*; one of which is termed the *great or right lobe*; the other, the *small or left lobe*. These two lobes are distinguished above, by a membranous ligament; and below very plainly, by a considerable scissure lying in the same direction with the superior ligament.

The eminences on the concave side of the liver belong to the great lobe. The principal eminence is a sort of triangular or pyramidal apophysis situated backward near the great scissure which distinguishes the two lobes.

This triangular eminence is termed *lobulus Spigelii*, or simply the *small lobe of the liver*. One of its angles advances a considerable way toward the middle of the lower side of the great lobe, and is lost there. Toward the fore-side, there is another eminence less prominent but broader; and to this eminence and the former, the ancients gave the general name of *portæ*.

The depressions on the concave or lower side of the liver are four in number. The first is the scissure that separates the two lobes, which runs across the concave side, from the eminences already mentioned, to the anterior edge, where it terminates by a notch of different depths in different subjects. This is termed the *great scissure of the liver*.

The second depression is situated transversely between the two eminences of the great lobe, and filled by the sinus of the vena portæ. The third depression is backward, between the great lobe and lobulus Spigelii, and the vena cava passes through it. The fourth is a kind of sulcus between the lobulus and small lobe of the liver, which in the fœtus served to receive a venal canal lost in

adults, in whom it appears only as a kind of ligament. This sulcus is in some measure a continuation of the great scissure, and joins the vena cava by an acute angle.

Besides these four depressions, there is one on the fore-part of the great lobe, in which the vesicula fellis is lodged; and it sometimes runs as far as the edge, where it forms a small notch. We may likewise reckon among these depressions, a small superficial cavity in the posterior and lateral part of the lower side of the great lobe, by which it rests on the right kidney; and likewise a superficial cavity in the left lobe, where it runs over the stomach.

Lastly, on the posterior edge of the liver, there is a great sinus common to both lobes, which gives passage to the spina dorsi and œsophagus, near the place where the vena cava descends.

The convex side of the liver is commonly connected to the diaphragm by three ligaments, which are only continuations of the membranous lamina of the peritonæum. One lies near the edge of the extremity of each lobe, and one in the middle, and they are accordingly termed the *right, middle, and left ligaments*. There is a cellular substance in the duplicature of each, in which the blood-vessels and lymphatics run, and which sends off a kind of lamina into the substance of the liver.

The right ligament sometimes connects the great lobe to the cartilages of the false ribs; and the left ligament, or that of the small lobe, is often double, and advances toward the middle ligament. This middle ligament begins low, in the great scissure of the liver, near the eminences called *portæ*, and from thence passes thro' the anterior notch and over the convex side of the liver at the union of the two lobes, and is fixed obliquely in the diaphragm.

It is likewise fixed along the upper and inner part of the vagina of the right musculus rectus of the abdomen, in such an oblique manner as to be nearer the linea alba below than above.

Besides these ligaments the great lobe of the liver is likewise connected to the right ala of the tendinous portion of the diaphragm, not by a ligament, but by a broad and immediate adhesion, without the intervention of the membrane of the peritonæum, which is only folded quite round this adhesion, to form the external membrane of all the rest of the body of the liver.

The middle ligament, called improperly *ligamentum hepatis suspensorium*, contains in its duplicature a thick white rope, like a round ligament, which was the umbilical vein in the fœtus. Thus the lower part represents a falx, the convex edge of which is sharp, and the other rounded.

All these ligaments serve to keep the liver in its proper situation, and to hinder it from inclining too much towards either side: But we must not imagine that any of them serve to suspend it; because it is sufficiently supported by the stomach and intestines, especially when they are filled.

When the stomach is empty, or when we fast longer than ordinary, it is a common expression to say *the stomach pinches us*. As the liver is not then sustained by the stomach and intestines, it descends by its own weight, and

and chiefly by the means of the middle ligament pulls the diaphragm along with it. It is in that place therefore that we have this uneasy sensation, and not at the superior orifice of the stomach, as is commonly believed.

The liver is composed of several kinds of vessels, the ramifications of which are multiplied in an astonishing manner, and form by the intertexture of their capillary extremities, an innumerable collection of small pulpy, friable corpuscles, which are looked upon to be so many organs designed to separate from the mass of blood a particular fluid termed the *bile*.

The greatest part of these vessels from one end to the other is included in a membranous vagina called *capsula vena portæ*, or *capsula Glissoni*.

The trunk of the vena portæ is situated transversely between the broad anterior eminence of the great lobe of the liver, and the root of the lobulus, in a particular scissure, and forms what is called the *sinus of the vena portæ*. From this sinus five principal branches go out, which are afterwards divided into millions of ramifications through the whole substance of the liver.

At this place the vena portæ lays down the common office of a vein, and becomes a kind of artery as it enters, and is again ramified in the liver. The extremities of all these ramifications of the trunk of the vena portæ hepatica end in the pulpy friable corpuscles which seem to be thick villous folliculi.

Its in these folliculi that the bile is secreted, and it is immediately collected in the same number of extremities of another kind of vessels, which unite by numerous ramifications into one common trunk. These ramifications are termed *pori bilarii*, and the trunk *ductus hepaticus*; and the ramifications of these two kinds of vessels are invested together by the capsula of the vena portæ.

The blood, deprived of this bilious fluid, is reconveyed to the heart by a great number of venal ramifications, which afterwards unite into three principal branches, besides others that are less considerable, that terminate in the vena cava, and are all called by the name of *vena hepatica*.

The capillary extremities of the ramifications of the vena cava, join those of the vena portæ, and accompany them through the liver; and yet the great branches of both veins intersect each other in several places.

The ductus hepaticus, or trunk of the pori bilarii, having run a little way, joins another canal called *ductus cysticus* or *vesicularis*, because it comes from the vesicula fellis. These two united ducts form a common trunk named *ductus cholidochus*, because it conveys the bile. This duct having reached the incurvation of the duodenum, insinuates itself through the coats of that intestine, and opens into the cavity thereof, not by a round papilla, but by an oblong orifice, rounded at the upper part, and contracted at the lower, like the spout of an ewer, or like a common tooth-picker.

The gall-bladder is a kind of small bag shaped like a pear, that is, narrow at one end and wide at the other. The wide extremity is termed the *fundus* or *bottom*, the narrow extremity the *neck*, and the middle portion the *body*. About one third of the body of the vesicula lies in a depression on the concave side of the liver, from

the trunk or sinus of the vena portæ, where the neck is situated to the anterior edge of the great lobe, a little toward the right side, where the bottom is placed.

The gall-bladder is composed of several coats; the outermost of which is a continuation of that which invests the liver, and consequently of the peritonæum.

The second coat is fleshy, and made up of two strata, one longitudinal, the other transverse, the fibres of which have nearly the same irregular direction with those of the stomach; and this disposition of the fibres in these viscera is owing to the different diameters in the several portions of them, and to their incurvation.

These two coats are connected by a cellular substance continued between the body of the vesicula and the liver, all the way, to a whitish stratum, which is looked upon as the third coat of the gall-bladder answering to the tunica nervosa of the intestines.

The innermost or fourth coat has on the inside a great number of reticular folds, filled with small lacunæ, like perforated papillæ, especially near the neck of the vesicula where these folds are longitudinal, and afterwards form a kind of small pylorus with plaits of the same nature with those in the great one. These lacunæ are looked upon to be glands.

That side of the body of the vesicula which lies next the liver is connected to that viscus by a vast number of filaments, which run a great way into the substance of the liver; and among these filaments there are some ducts which form a communication between the pori bilarii and vesicula. They are most numerous near the neck of the vesicula, and they are named *ductus cysto-hepatici*, or *hepatico-cystici*.

The neck of the vesicula is formed by the contraction of the small extremity; and this neck bending afterwards in a particular manner, produces a narrow canal named *ductus cysticus*.

The neck of the vesicula is nearly of the same structure with the other parts. It has on the inside several reticular rugæ and some folds which appear like fragments of valvulæ conniventes, situated very near each other, from the neck to the contraction of the cystic duct. The first of these folds is pretty broad and large, and almost circular; the next is more oblique, and smaller in size; and the rest diminish in the same manner.

The bile which passeth through the ductus hepaticus into the cholidochus, may be called *hepatic*; and that which is collected in the vesicula fellis, may be termed *cystic*. The hepatic bile flows continually through the ductus cholidochus into the duodenum, whereas the cystic bile flows only by reason of plentitude or by compression.

The uses of the liver shall be explained after the description of pancreas, spleen, and omentum, all these viscera having a great relation to the liver.

## PANCREAS.

THE pancreas is a long flat gland, of that kind which anatomists call *conglomerate*, situated under the stomach, between the liver and the spleen. Its figure resembles that of a dog's tongue; and it is divided into two sides, one superior, the other inferior; two edges, one anterior,

rior, the other posterior; and two extremities, one large, which represents the basis of a tongue, and one small and a little rounded like the point of a tongue.

The pancreas is situated transversely under the stomach, in the duplicature of the posterior portion of the mesocolon. The large extremity is connected to the first incurvation of the duodenum, and from thence it passes before the rest of that intestine, all the way to its last incurvation; so that a great part of the duodenum lies between the pancreas and the vertebræ of the back. The small extremity is fixed to the omentum near the spleen.

The pancreas is composed of a great number of soft glandular molecule, combined in such a manner, as to exhibit the appearance of one uniform mass on the outside, the surface of which is rendered uneven only by numerous small convexities, more or less flattened. When these molecule are separated a little from each other, we find along the middle of the breadth of the pancreas, a particular duct, in which several smaller ducts terminate laterally on each side, like small rami in a stem.

This canal, named *ductus pancreaticus*, or *ductus Virsungi*, is very thin, white, and almost transparent, and the extremity of the trunk opens commonly into the extremity of the ductus cholidochus. From thence it diminishes gradually, and terminates in a point, next the spleen. The small lateral branches are likewise pretty large near the trunk, and very small toward the edges of the pancreas, all of them lying in the same plane like the branches of the common fern.

The pancreatic duct is sometimes double in man, one lying above the other. It is not always of an equal length, and sometimes runs in a winding course, but always in the same plane; and it is nearer the lower than the upper side of the pancreas. It pierces the coats of the duodenum, and opens into the ductus cholidochus, commonly a little above the prominent point of the orifice of that canal; and sometimes it opens immediately into the duodenum.

### S P L E E N.

THE spleen is a bluish mass, something inclined to red, and of a long oval figure, being about seven or eight fingers-breadth in length, and four or five in breadth. It is of a softish substance, and is situated in the left hypochoandrium, between the great extremity of the stomach, and the neighbouring false ribs, under the edge of the diaphragm, and above the left kidney.

The inner or concave side is divided by a longitudinal groove or scissure, in two planes or half-sides, one upper, the other lower; and by this groove, the vessels and nerves enter in human subjects. The superior half-side is broader and more concave than the inferior, being proportioned to the convexity of the great extremity of the stomach. The inferior half-side lies backward on the left kidney, and forward on the colon; and sometimes this side of the spleen appears to have two superficial cavities, one answering to the convexity of the stomach, the other to that of the colon. The convex side of the spleen is turned to the left ribs.

It is connected to the stomach, by the vessels called *vasa brevia*; to the extremity of the pancreas, by ramifications of the splenic artery and vein; and to the omentum, by ramifications which the same artery and veins send to the spleen, and which run in the longitudinal groove.

It is connected to the edge of the diaphragm by a particular membranous ligament of different breadths in different subjects, fixed in its convex side, sometimes near the upper edge, and sometimes near the lower.

The structure of the spleen is not easy to be unfolded in man, and it is very different from that of the spleens of brutes, from which both public and private demonstrations are commonly made.

Its coverings adhere to it so closely in man, that it is difficult to distinguish the common from the proper coat; whereas in some brutes, such as oxen, sheep, &c. we easily find two coats separated by a cellular substance. This covering seems to be no otherwise a continuation of the peritonæum than by the intervention of the omentum and mesocolon.

In man the substance of the spleen is almost wholly vascular. In oxen the substance of the spleen is chiefly reticular, and in sheep it is cellular. In oxen and sheep there are no venal ramifications, but instead thereof only open sinuses disposed like branches, except a small portion of a venal trunk perforated on all sides, at the extremity of the spleen.

In the human spleen we see something like glandular corpuscles, as in those of other animals; and there are numerous venal ramifications through its whole extent. Between these ramifications we every where observe an appearance of extravasated blood, lying in a kind of filamentary transparent and very delicate substance expanded through the whole spleen.

This filamentary substance, having surrounded all the ramifications, terminates in almost imperceptible cells which communicate with each other.

### OMENTUM & APPENDICES EPIPLOICÆ.

THE omentum is a large, thin, and fine membranous bag, surrounded on all sides by numerous portions of fat, which accompany and even invest the same number of arteries and veins adhering closely to each other.

The greatest part of it resembles a kind of flat purse or a sportsman's empty pouch, and is spread more or less on all the small intestines from the stomach to the lower part of the regio umbilicalis. Sometimes it goes down to the lower part of the hypogastrium, and sometimes does not reach beyond the regio epigastrica. It is commonly plaited or folded in several places, especially between the bands of fat.

It is divided into a superior and inferior, an anterior and posterior, and a right and left portion. The superior portion is in a manner divided into two borders, one of which is fixed along the great curvature or convex side of the arch of the colon, and the other along the great curvature of the stomach. The commissure or union of these two borders on the right side, is fixed to the common ligament or adhesion of the duodenum and colon.

colon, and to the contiguous parts of these intestines. That on the left side is fixed to the longitudinal scissure of the spleen, to the extremity of the pancreas, and to the convex side of the great extremity of the stomach. It is likewise fixed to the membranous ligament which sustains the ductus cholidochus, and connects it to the vena portæ ventralis.

Below these adhesions, the other portions, that is, the anterior, posterior, two lateral and inferior portions, which last is the bottom of the succulus epiploicus, have commonly no fixed connections, but lie loose between the fore-side of the cavity of the abdomen and intestines.

The membrane of the omentum is through its whole extent made up of two extremely thin laminæ joined by a cellular substance; the quantity of which is very considerable along the blood-vessels, which it every where accompanies in broad bands, proportioned to the branches and ramifications of these vessels. These cellular bands are more or less filled with fat according to the corpulency of the subject.

Besides this large membranous bag, there is another much smaller, which differs from the large one, not only in size, but also in figure, situation and connexion; and this is the *little omentum*. This small bag is fixed by its whole circumference, partly to the small curvature of the stomach, and partly to the concave side of the liver before the sinus of the vena portæ, so as to surround and contain the prominent portion of the lobulus.

The little omentum is thinner and more transparent than the other, and its cavity diminishes gradually from the circumference to the bottom. Its structure is pretty much the same with that of the great omentum, it being composed of two laminæ, with a mixture of the same portions of fat, which are considerably finer than in the other.

The fatty appendices of the colon and rectum appear to be a kind of small omenta or appendices epiploicæ. They are situated at different distances along these intestines, being particular elongations of their common or external coat. They are of the same structure with the great omenta, and there is a cellular substance contained in their duplicature, more or less filled with fat, according as the subject is fat or lean.

#### Uses of the Abdominal Viscera.

THE intestines in general finish what the stomach had begun. The alimentary pulp having been sufficiently prepared by the succus gastricus, or lymph of the stomach, undergoes a further change by the intestinal lymph, bile, and pancreatic juice, by which the milky liquor called *chyle* is produced, and this liquor rendered fluid enough to enter the lacteal vessels through the tunica villosa of the small intestines, while the grosser portion of the aliment continues its course, and becoming gradually thicker as it advances toward the great intestines, is there collected by the name of *feces*.

The valve of the colon, which might more properly be termed *sphincter* or *pylorus* of the ileum, hinders the feces from returning into the small intestines.

The glandular lacunæ of the intestines furnish conti-

nually a kind of mucilage, which not only defends the internal coat from the acrimony of the feces, but serves also to lubricate these feces in proportion to their different degrees of solidity.

The intestinum rectum is the last reservoir of the feces. The great thickness of its muscular coat, and the great number of longitudinal fibres by which this thickness is chiefly formed, enable it to yield to the collected feces to so great a degree, as to represent a large bladder or stomach. The muscoli levatores ani serve to suspend the lower portion of this intestine, especially when full; and it is partly by the contraction of these muscles which overcome the sphincter of the anus, that the feces are discharged out of the body. These sphincters form the third pylorus of the whole alimentary canal.

The mesentery and mesocolon connect the intestines, in such a manner, as that they cannot be twisted or run into knots, without hindering them from sliding and yielding to each other according to the different postures of the body, or according as they are more or less empty or full.

The adhesions of the mesentery form the convolutions of all the small intestines into a large bundle, irregularly round, which fills a great part of the cavity of the abdomen, from the epigastrium downward.

The mesocolon by its adhesion to the colon forms a kind of septum transversum, between the small intestines and the viscera contained in the epigastrium; and this septum supports the liver and stomach under the arch of the diaphragm, just as much as it is sustained by the intestines.

The breadth of the mesentery and mesocolon affords a large extent to the ramifications of the arteries, veins, and nerves, distributed through them by innumerable communications and anastomoses, by means of which any portion of the intestines may be supplied, though the principal branch which leads to it should happen to be compressed or obstructed.

The cellular substance in the duplicature of the mesentery and mesocolon, serves not only for a soft bed to all these ramifications, but also to contain those collections of fat necessary for the formation of the bile; and the cellular substance of the mesentery has likewise one use peculiar to it, which is to invest the lymphatic glands and lacteal vessels, and upon this account it is thicker than that of the mesocolon.

The lacteal vessels being first formed by a copious reticular texture round the circumference of the intestines; resembling the vascular network of that canal, and afterwards uniting every where through the duplicature of the mesentery, with the arterial ramifications which they likewise accompany in many places; it is easy to conceive, that the pulsation of the mesenteric arteries must propel the chyle in the lacteal vessels from the intestines to the receptaculum chyli, that motion being suitable to the direction of their valves.

The liver is the principal organ for the secretion of the bile. The villi of that immense number of glandular cells of which it is composed, filtrate continually from the blood of the vena portæ small drops of bile, which afterwards insinuate themselves into the pori bilarii, and

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are in part lodged in the vesicula fellis, and in part run directly into the duodenum.

The spleen, omentum, appendices epiploicæ, adipose strata of the mesentery, and those of the great intestines, and even the pancreas, with the whole series of glands in the intestinal canal, seem to contribute to the formation of the bile, as so many auxiliary or rather preparatory organs.

The vesicular bile appears to be more exalted than that in the hepatic duct; and by meeting in the ductus cholidochus, they seem to compose a third kind of bile, which without the cystic or vesicular bile would perhaps be too mild, and too acrid without the hepatic. This bile mixes in the duodenum with the pancreatic juice, and with that of the intestinal glands; and from this mixture a fluid results, which is proper to separate the chylous matter from the gross and useless part of the alimentary pulp, as it comes from the stomach.

#### RENES & URETERES.

THE kidneys are two pretty solid, glandular bodies, situated in the posterior part of the cavity of the abdomen, on each side of the lumbar vertebræ, between the last false ribs and ossa ileum. The right kidney lies under the great lobe of the liver, and is consequently lower than the left, which lies under the spleen.

The figure of the kidneys resembles that of a large bean, their circumference being convex on one side, and concave on the other. The concave side is turned to the vertebræ, and the convex side the opposite way.

In each kidney we observe a fore and back side, an upper and lower extremity, a great and small curvature, and a convexity and concavity.

The back-side is broader than the fore-side; and the upper extremity is a little broader and more incurvated than the lower. The depression in the small curvature is oblong and uneven, resembling a sinus, surrounded by several tubercles; and as it is turned a little toward the fore-side, this side is something narrower than the other.

The kidneys are surrounded by a very loose membranous and cellular covering, called *membrana adiposa*, because in fat persons the cells of this substance are filled with fat.

The proper coat or membrane of the kidneys is composed of two laminae, between which there is likewise a very fine cellular substance, which may be made sensible by blowing through a pipe between the two laminae.

The external lamina is very thin, and adheres closely to the internal lamina, by means of the cellular substance. The internal lamina penetrates every where, by numerous elongations, into the substance of the kidney, from which it cannot be separated without tearing.

The surface of the external lamina is very smooth, polished and glistening, and it renders the whole surface of the kidney very even and uniform.

The blood-vessels having entered the kidneys, are ramified every way; and these ramifications send out other capillary rami, which go all the way to the surface, where they appear like irregular stars, and furnish the proper membrane of the kidneys.

The proper membrane having surrounded the kidney all the way to the sinus, joins the vessels at that place, and accompanies all their ramifications through the body of the kidney, in form of a vagina or capsula.

We may distinguish three kinds of substances in the kidney; an exterior substance, which is thick, granulated, and in a manner cortical; a middle substance, which is medullary and radiated, called *striata, sulcata, or tubularis*, because it seems to be made up of radiated tubes; and an inner substance, which is only a continuation of the second, and terminates on the inside by papillæ, for which reason it is called *papillaris*.

The papillæ, which are only a continuation of the medullary substance, are often a little paler than that substance. They are ten or twelve in number, very distinct from each other, resembling the same number of cones, with very broad bases and obtuse apices.

At the point of each papilla we see, even without a microscope, in a small depression, several very small holes, through which little drops may be perceived to run when the papillæ are compressed. These are little drops of urine, which being filtrated, partly in the cortical, partly in the medullary or tubular substance, do afterwards pass through the substance of the papillæ, and are discharged by these orifices.

Each papilla lies in a kind of membranous calix or infundibulum, which opens into a common cavity called the pelvis. This pelvis is membranous, being of the same structure with the calices, of which it is a continuation; and its cavity in man is not uniform, but distinguished into three portions, each of which contains a certain number of infundibula or calices, together with the papillæ which lie therein.

At the place where these infundibula surround the bases of the papillæ, they send productions into the medullary or radiated substance of the kidney, which accompany the blood-vessels, and serve for capsulae or vaginae to all the vascular arches, both arterial and venal, and to their different ramifications, quite through the cortical substance, and as far as the surface of the kidney.

After the infundibula have contracted in a conical form round the apices of the papillæ, each of them forms a small short tube or gullet, which, uniting at different distances along the bottom of the sinus of the kidney, form three large tubes, which go out from the sinus in an oblique direction from above downwards, and immediately afterwards unite into one trunk.

This trunk becomes a very long canal, called the ureter. In men the three tubes supply the place of what is called the pelvis in brutes, and might properly be called the roots or branches of the ureters than the pelvis. The ureters are commonly two in number, one for each kidney.

The situation of the trunk, and of the roots and branches of each ureter, with respect to the renal artery and vein, is in the following manner: The artery is in the upper part of the sinus, and partly before the vein. The vein is about the middle, and between the artery and ureter. The ureter is in the lower part, a little behind the vein, and it is partly surrounded by one branch of the artery.

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The ureters run down obliquely, and with a very small degree of inflection, from the kidneys to the lateral parts of the inner or anterior side of the os sacrum, and passing between the rectum and bladder they terminate in the last of these viscera.

They are composed of three proper coats; the first of which, that surrounds the rest, is of a whitish colour, and of a very compact filamentary texture, being stretched with difficulty, and appearing like a filamentary substance degenerated. The next coat is of a reddish colour, stronger than the first, and made up of different strata of fibres, which intersect each other; but it is very hard to determine, whether they are muscular, or simply membranous.

### GLANDULÆ RENALES, *velgo* CAPSULÆ ATRABILARIÆ.

IMMEDIATELY above each kidney, lies a glandular body, called by the ancients capsulæ atriliaræ; by others capsulæ renales, renes succenturiati, and glandulæ renales. They are situated on the upper extremity of each kidney a little obliquely, that is, more toward the inner edge and sinus of the kidney than toward the outer convex edge.

Each gland is an oblong body with three sides, three edges, and two points, like an irregular crescent with its great or convex edge sharp, and the small concave edge broad. Its length is about two thirds of the greatest breadth of the kidney, and the breadth of its middle portion is about one third of its extent between the two extremities, sometimes more, sometimes less. Its colour is a dark yellow.

It has one anterior, one posterior, and one lower side, which last may be termed the basis; and it has one upper, and two lower edges, whereof one is anterior, the other posterior. The upper edge may be called the crista, and the two lower edges the labia.

The surface of these glands is uneven; the fore side is the broadest, and the lower side or basis the narrowest. Along the middle of the anterior side, a ridge runs from the edge of the inner extremity, a little above the basis, to the point of the other extremity, and divides this side into two equal parts, like the middle rib of the leaf of a tree; and on the lower side, under the basis, there is a kind of raphe or suture.

The blood-vessels of these glands come from the arteriæ, and venæ renales, and diaphragmaticæ, and likewise from the aorta and vena cava, from the arteria cæliaca, &c. These vessels are termed the capsular arteries and veins; and as they enter the glands, they seem to be invested by a vagina.

In the inside of these capsulæ, there is a narrow triangular cavity, the surface of which is full of short strong villi of a yellowish colour; but in children it is reddish, and of a dark brown in aged people. The sides of this cavity are connected by a great number of filaments; and they appear to be wholly glandular, that is, to be filled with very fine small folliculous corpuscles.

This cavity contains an unctuous viscid liquor, of a yellowish red colour, which with age changes gradually

into a yellowish purple, a dark yellow, and a black yellow; and sometimes it is perfectly black; but even then, if it be spread thin on a large surface, it appears yellow.

The uses of these renal glands have not as yet been discovered; and all that we know about the liquor contained in them, is, that it resembles the bile. They are very large in the fœtus, and diminish in adults.

### VESICA URINARIA.

THE bladder is a kind of membranous and fleshy pouch or bottle, capable of dilatation and contraction, situated in the lower part of the abdomen, immediately behind the symphysis of the ossa pubis, and opposite to the beginning of the intestinum rectum. The figure of it is nearly that of a short oval. It is broader on the fore and back sides, than on the lateral parts; rounder above than below when empty, and broader below than above when full.

It is divided into the body, neck, and bottom; into an anterior, posterior, and two lateral parts. The upper part is termed the fundus or bottom; and the neck is a portion of the lower part, which is contracted like the gullet of some vessels.

The bladder is made up of several coats. That part of the external coat which covers the upper, posterior and lateral sides of the bladder, is the true lamina or membrane of the peritonæum; and the rest of it is surrounded by a cellular substance, by the intervention of which, the peritonæum is connected to the muscular coat.

The proper coats are three in number, one muscular, one nervous, and one villous, which is the innermost. The muscular coat is composed of several strata of fleshy fibres; the outermost of which are mostly longitudinal; the next to these are more inclined toward each hand; and the innermost, more and more oblique; and they become at length almost transverse.

The nervous coat is nearly of the same structure with the tunica nervosa of the stomach.

The internal coat is something granulated and glandular, and a mucilaginous serum is continually discharged through it, which moistens the inner surface of the bladder, and defends it against the acrimony of the urine.

At the top of the bladder, above the symphysis of the ossa pubis, we observe a ligamentary rope, which runs up between the peritonæum and the linea alba of the abdomen, all the way to the navel, diminishing gradually in thickness as it ascends. This rope had a particular use in the fœtus, as shall be said in another place. It is sufficient to add here, that it is in part originally a production of the inner coats of the bladder, which production is termed urachus.

This rope is composed likewise of two other ligamentary elongations, which are the extremities of the umbilical arteries. These arteries come from the hypogastricæ, run up by the sides of the bladder, and remain hollow and filled with blood, even in adults, as high as the middle of the bladder, through all which space they likewise send off ramifications. Afterwards they lose their cavity, and become ligamentary as they ascend.

At the upper part of the bladder, they approach each other; and, joining the urachus, form that rope, which may be termed the superior ligament of the bladder.

The lower part of the bladder, which deserves the name of *fundus* much better than the upper part, is perforated by three openings, one anterior, and two posterior. The anterior opening is formed by an elongation of all the proper coats, in form of a gullet, turned much in the same manner with the inner orifice of the rostrum of the head of an alembic. This elongation is called the neck of the bladder, the description of which belongs to that of the parts of generation in men.

The other two openings in the true fundus of the bladder, are formed by the ureters, which, in their course downward already described, run behind the spermatic vessels, and then behind the lower part of the bladder, approaching each other. Each ureter lies between the umbilical artery and vas deferens of the same side, the artery lying on the outside of the ureter, and the vas deferens on the inside.

Afterwards they get between the vasa deferentia and the bladder, crossing these canals: and then at about a finger's breadth from each other, they begin to pierce the coats of the bladder. They run a little way between the muscular and nervous coats, and open into the bladder obliquely, something nearer each other than when they first entered its coats.

The orifices of the ureters in the bladder, are something oval, and narrower than the cavity of the ureters immediately above them. The edge of these orifices is very thin, and seems to be formed merely by the union of the internal coat of the bladder with that of the ureters.

Besides the ligaments already mentioned, there are likewise two small ones, by which the anterior part of the true fundus of the bladder is connected to the ossa pubis, which shall be described with the neck and sphincter after the history of the parts of generation in both sexes.

## THE PARTS OF GENERATION IN MALES.

THE spermatic arteries go out most commonly from the anterior part of the inferior aorta, near each other, and about an inch lower than the arteriæ renales.

They run down obliquely in the posterior part of the abdomen, within the cellular substance of the peritonæum, passing insensibly from behind forward; and so parting gradually more and more from the aorta, they cross over the foreside of the ureters, and run through the openings or rings of the abdominal muscles, along with the elongations or productions of the cellular portion of the peritonæum.

They are small at their origin; and in their course downward, they give off pretty considerable lateral ramifications to the membrana adiposa, peritonæum, and also to the mesentery.

They sometimes pass through the areolæ, or meshes of the spermatic veins; and before they go out of the abdomen, they are divided into very fine rami, which run

in a more or less winding course, almost parallel to each other.

Afterwards they enter the cellular productions of the peritonæum, which serve them for vaginæ. They do not fluctuate indifferently from one side to the other of these vaginæ; but are connected along their inner surface by thin membranous laminæ, which are likewise continuations of the cellular substance of the peritonæum.

The arteries continue the same winding course within these vaginæ, passing before the vasa deferentia, which are likewise contained in them; and at length they terminate by ramifications in the epididymes and testes.

The testes are two glandular bodies, situated near each other, without the abdomen, below the interstice between the groins in an adult. The ancients named them *didymi* or *gemini*. Their size is nearly that of a pigeon's egg, and they are of an oval figure, a little flattened at each side. We may consider in each testicle, two extremities, two edges, and two sides. One extremity is situated forward, and a little upward; the other backward, and a little downward; and their edges lie upward and downward.

At the upper edge, they have each an appendix, called epididymis, together with which it is involved in several coverings; and they are both suspended in a common covering, called the scrotum.

Each testicle is a spermatic gland formed by a vast number of fine whitish tubes, folded and twisted in different manners, and distributed in different fasciculi, between membranous septa; the whole being surrounded by a strong common covering, named *tunica albuginea*.

These septa are disposed longitudinally, divaricating from each other on one side, and approaching on the other. They approach each other along one edge of the testicle, and terminate in a long narrow whitish body, as in a kind of axis.

From thence they divaricate in a regular manner, and are fixed by their opposite edges in the inner surface of the tunica albuginea, of which they appear to be a continuation. This white body may be termed the nucleus of the testicle.

From this description, we see that all these septa are not of an equal breadth; that the interstices between them are in some measure triangular; and that the extent of the small tubes, which lie therein, must be very considerable. They have been reckoned to amount to many elis, by taking the sum of all their several portions; and they may be easily unfolded by a long maceration, which destroys the delicate substance by which all their folds and convolutions are connected and tied down.

All these small canals seem to terminate by a smaller number of common trunks at the white body or nucleus already mentioned; which trunks do afterwards pierce the upper part of the anterior extremity of the testicle, and are disposed in several folds along the lateral external part of the upper edge, all the way to the posterior extremity. From this union arises a long whitish plaited fasciculus or bundle, called epididymis, or appendix to the testicle.

The epididymis thus formed, may be reckoned a production of the testicle, or a kind of testis accessorius; and

and it resembles in some measure an arch supported by its center or frame. It is more contracted at the middle, than at the extremities, by which it is closely united to those of the testicle.

Between its extremities it does not immediately touch the testicle, but is only loosely connected to it, by the duplicature of a very fine and almost transparent membrane, as by a kind of ligament. This membrane is the continuation and duplicature of the tunica albuginea or proper coat of the testicle, which having supplied the place of a ligament to the epididymis afterwards invests it.

The epididymis is flat, a little concave on the under side, or that next the testicle, irregularly convex on the upper side, or that turned from the testicle; and these two sides are distinguished by two angular edges; by the innermost of which, it is connected to the testicle, in the manner already said; but the outer edge and flat side are loose and free.

The anterior extremity or head of the epididymis arises from the testicle; and the posterior extremity or tail, which likewise adheres very closely to it, is incurvated from behind, forward, and a little upward, and contracting by degrees, forms a particular canal, termed vas deferens, which shall be described after the scrotum.

The scrotum is the cutaneous covering of the testes. Outwardly, it is a bag common to both, formed by a continuation of the skin of the neighbouring parts, and commonly very uneven, having a great number of rugæ on its outer surface. Interiorly it is fleshy, and forms a muscular capsula for each testicle, termed dartos.

The exterior or cutaneous portion of the scrotum is nearly of the same structure with the skin in general, of which it is a continuation; only it is something finer, and it is likewise plentifully stored with sebaceous glands and bulbs or roots of hairs.

Though it is a common covering for both testicles, it is nevertheless distinguished into two lateral parts by a superficial and uneven prominent line which appears like a kind of suture, and from thence has been termed *raphe*.

This line is a continuation of that which divides in the same manner the cutaneous covering of the penis; and it is continued through the perinæum, which it divides likewise, all the way to the anus. It is only superficial, and does not appear on the inside of the skin.

The inner surface of this cutaneous bag is lined by a very thin cellular membrane, through which bulbs and glands appear very distinctly when we view its inside.

The dartos, or fleshy portion of the scrotum, is a true cutaneous muscle; the fibres of which are for the most part strongly connected to the skin, running through the cellular substance which lies between these two portions in place of a membrana adiposa, but without the least appearance of fat. This muscle is thin, and by the disposition of its fibres forms a bag with two cavities, or two small bags joined laterally to each other, and contained within the cutaneous portion.

The lateral parts of these two bags, which are turned from each other, are longer than those which are joined together; and by this union a septum is formed between the testes, which may be called *mediastinum scroti*.

The *raphe* or suture already mentioned adheres to the

edge of this septum, and thereby braces down the middle of the cutaneous portion, which from thence appears to have in part two cavities.

The aponeurotic or ligamentary expansion of the dartos is fixed in the ramus of the os pubis, between the musculus triceps and the origin of the corpus cavernosum of the same side, all the way to the lower part of the symphysis of these bones.

The vasa deferentia are two white solid flattened tubes, one lying on the right side; the other on the left. From the epididymis, of which they are continuations, each of them runs up in the cellular vagina of the spermatic vessels, as high as the openings in the abdominal muscles; the blood-vessels lying forward, and the vas deferens behind them.

This fasciculus, thus formed by the blood-vessels, vas deferens, and their common covering, is termed the spermatic rope. The covering is smoother on the outer than on the inner side, and for that reason it has been looked upon as a vagina; the internal substance of which is most cellular, and connects all the vessels together, while the external forms a covering to invest them.

The vas deferens having reached the membranous lamina of the peritonæum, where that lamina runs over the orifice of the vagina, separates from the blood vessels, and runs backward, in form of an arch, in the cellular substance of the peritonæum, as far as the nearest side of the bladder.

It passes afterwards behind the body of the bladder, to which it adheres very closely, as also to the lamina of the peritonæum which covers it, and then continues its arched course towards the neck of the bladder, where both vasa deferentia meet, and their arches terminate.

In this course, the vas deferens passes behind and crosses the neighbouring umbilical artery; crosses the extremity of the ureter of the same side, in its passage between that extremity and the bladder; and having got behind the bladder, it meets the vas deferens of the other side between the insertions of the ureters, and they run down together to the neck of the bladder.

This canal, which at the origin of the epididymis is pretty large and plaited, becomes immediately afterward smaller and smoother, and continues in that form till it gets behind the bladder, where it begins again to be larger and more uneven.

It arises from the angular portion or posterior extremity of the epididymis, and from thence runs forward in a very oblique course, on the posterior half of the epididymis, where it is a little incurvated as it joins the back-side of the spermatic vessels.

The cavity of the vas deferens is cylindrical, though the whole tube is flat, and its external circumference oval, and the cavity enlarges as it passes behind the bladder. The termination of these canals must be referred to the history of the urethra.

The particular coverings of the testes are commonly called coats; and they are reckoned to be three in number; the tunica muscosa, named cremaster, vaginalis and albuginea. The first two are common to each testicle, and to the spermatic rope that belongs to it; and the third is peculiar to the testicle alone.

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The tunica vaginalis is the most considerable of the three, and must be described first, in order to conceive the structure and connection of the cremaster, which is very improperly called a coat. The albuginea has been already described with the testes.

The tunica vaginalis is a continuation of the vagina of the spermatic rope, which, as it approaches the testicle, is gradually dilated, and forms two capsulæ, one contained within the other, the external being the longest and broadest at bottom; so that there is a void space there left between them, in which the testicle is lodged.

The inner surface of this coat is lined by a fine membrane, which strengthens the bottom of the vagina, and forms a kind of diaphragm, which prevents all communication between the vagina of the spermatic rope and the tunica vaginalis of the testicle.

The cremaster, improperly termed a coat, is a thin muscle or fleshy plane, which runs down round the vagina of the spermatic rope, and terminates in the tunica vaginalis of the testicle.

It surrounds almost the whole vagina, and afterwards expands itself on the upper and external part of the tunica vaginalis, in which it is inserted and lost.

It arises partly from the ligamentum Fallopii, and partly from the lower edge of the internal oblique muscle of the abdomen; and on this account it seems sometimes to arise from the spine of the os ilium.

The corpora cavernosa are two ligamentary and very limber tubes, united laterally to each side, through the greatest part of their length, and solid at their two extremities, two of which are connected together, and rounded like the end of a finger; the other two divaricate, like the branches of the greek Y, and diminishing gradually in size after the divarication, terminate in an oblique point. These divaricated and pointed extremities may be called the roots, and the round extremities the heads.

These two bodies are almost cylindrical, being round, and of an equal diameter from the roots to the heads, where they are in some measure conical. The ligamentary substance of their sides is elastic, and composed of fine close fibres, which are partly transverse, and partly more or less oblique.

The cavity of these ligamentary tubes is entirely filled by a strong cellular or cavernous substance, which does not seem to be a continuation of the substance of the sides. These cells communicate with each other, and are always more or less full of blood, resembling pretty much the cellular substance of the spleen; only with this difference, that the sides of the cells are thicker in these cavernous bodies, and without any additional substance.

By the union of the two corpora cavernosa, two external grooves are formed, one on the upper side, the other on the lower. The lower groove is something broader than the upper, and it is filled through its whole length by a third tube, narrower than the corpora cavernosa, called the urethra.

The roots of the corpora cavernosa are fixed, each, to the edge of the small ramus of the os ischium and os

pubis. They meet at the symphysis of the ossa pubis, where each of them becomes a cylindrical tube, and unites with the other in the manner already said.

The heads or rounded extremities join the basis of a distinct body, called the glans, which is an expansion of the urethra, and closely united to it.

By the union of the corpora cavernosa from their roots to their round extremities or heads, a particular septum is formed by the transverse fibres of both. Between the fibres of this septum several small void spaces are left, by which the corpora cavernosa communicate with each other.

The urethra is the third spongy tube which composes the penis, and it adheres to the corpora cavernosa through the whole length of the inferior groove formed by their union. It differs from the other two, both as it is narrower, and as it forms a true hollow canal. Its substance is spongy or cavernous, except a small portion next the bladder, and its inner and outer surfaces are membranous.

It is at first no more than a membranous canal continued from the anterior opening of the bladder, at the place called the neck of the bladder.

About a finger's breadth and an half from its origin, it joins a cavernous substance like that of the two other tubes, only smaller, which surrounds it through the whole extent of the inferior groove of the corpora cavernosa.

But before this spongy substance begins to surround the urethra, it forms a distinct oblong body, like a pear or onion, which is connected only to the lower convex side of the canal, and afterwards, being split on each side, invests it quite round. This body is called the bulb of the urethra, being larger than any other part of that canal, and divided interiorly by a very fine membranous septum, into lateral parts; and therefore when it is inflated, it appears to be double or with two heads.

The first portion of the urethra, or that which is not covered by the cavernous substance, and which from the bladder to the bulb is only a membranous canal, is sustained by a large solid whitish mass, of the figure of a chestnut, and situated between the bladder and the bulb of the urethra, its basis being toward the bladder, the apex or point toward the urethra, and the sides lying upward and downward.

This body is termed the prostate, from a greek word that expresses its situation before the vesiculae seminales, and implies a plurality, because it appears to be divided into two lateral lobes, by a hollow groove which runs through its upper side from the basis to the apex. The first portion of the urethra lies in this groove, adhering very closely to the prostates which surround it.

The body of the prostates lies on the intestinum rectum, and the apex is under the internal labium of the cartilaginous arch of the ossa pubis. The inner substance is spongy, but very compact; and in each lobe there are several folliculi which open into the first portion of the urethra, toward the bottom of the groove.

The spongy substance of the urethra, having reached the extremity of the corpora cavernosa, forms a large head, called the glans, which crowns the three spongy pillars,

pillars; with this difference however, that it is a continuation of the spongy substance of the urethra, and only adheres to the extremity of the corpora cavernosa without any direct communication.

The figure of the glans is that of a rounded cone, a little flattened at the lower part, and with an oblique prominent basis, the circumference of which is something greater than that of the corpora cavernosa.

The spongy substance of the glans is thick and uniform next the corpora cavernosa; but next the urethra, it is perforated by a continuation of that canal, and is there no thicker than the urethra before the formation of the glans.

Therefore the canal of the urethra does not lie in the middle of the glans, but continues its direct course thro' the lower flat side of it, all the way to the extremity, where it terminates by an oblong orifice.

All the convex surface of the glans is covered by a fine villous substance; and that again by a fine membrane, resembling the red part of the lips. The circumference of the basis of the glans has a double row of small papillæ, which may be reckoned sebaceous glands, from which a thick matter is discharged.

At the bottom of the cavity of the first portion of the urethra, or that which lies within the prostates, there is a small oblong oval eminence, pretty large on the back part, and terminating forward in a point, called *caruncula* or *verumontanum*. The large portion of it is commonly perforated by two holes, sometimes only by one, and very seldom by three; and these are the excretory orifices of the vesiculæ seminales. Each orifice has a small thin membranous border, which may serve for valves to the excretory ducts of the vesiculæ.

On each side of the large portion of the *caruncula*, there are five or six holes ranked in form of a crescent round its lateral parts; which are the orifices of the excretory ducts of the prostates that come from the folliculi already mentioned, and run in an oblique course to the orifices, in a kind of membranous duplicature.

The vesiculæ seminales are soft whitish knotty bodies, about three or four fingers breadth in length, one in breadth, and about three times as broad as thick, situated obliquely between the rectum and lower part of the bladder, in such a manner, as that their superior extremities are at a distance from each other, and their lower extremities united between those of the vasa deferentia, of which they imitate both the obliquity and the incurvation.

They are irregularly round on the upper part, and their breadth decreases gradually from thence. By the union of their lower extremities, they form a kind of fork, the branches of which are broad, and bent like ram's horns. These extremities are very narrow, and form a small neck, which runs behind the bladder toward its orifice, and constitutes its course in the groove of the prostates, through the substance of the contiguous portion of the urethra, till its extremities pierce the *caruncula* in the manner already said.

The inner substance of the vesiculæ is plaited, and in a manner distinguished into several capsule, by contorted folds. Their external surface is covered by a fine

membrane, which serves for a border and frænum to the folds, and is a true continuation of the cellular substance of the peritonæum. The vesiculæ may easily be unfolded, and all their contorsions streightened, and by this means they become much longer than in their natural state.

Their inner surface is villous and glandular, and continually furnishes a particular fluid, which exalts, refines, and perfects the semen, which they receive from the vasa deferentia, and of which they are the reservoirs for a certain time.

The passage of the vasa deferentia into the vesiculæ is very particular. It was observed, that these canals are incurvated behind the bladder, and that their contracted extremities unite at that place. They unite in an angle, and run between the contiguous extremities of the vesiculæ; and this union is so close, that the adhering portions seem to form only one middle septum, between two small tubes, each of which is formed, partly by the extremity of one vas deferens, and partly by that of the neighbouring vesicula.

This lateral union of the extremities of the vas deferens, and vesicula seminalis on each side, forms likewise a kind of short septum, which terminates in a crescent; like a small semilunar valve, and the extremity of the vas deferens is narrower than that of the vesicula. By this mechanism, the fluid contained in each vas deferens has liberty to enter the contiguous vesicula, but that contained in the vesicula cannot return into the other canal.

Afterwards the two small tubes, formed each by the extremities of the vas deferens and vesicula, run in between the basis of the prostates, and canal of the urethra; and perforating the sides of that canal obliquely, they terminate in the *caruncula*.

The inside of the canal of the urethra is lined by a fine membrane, full of capillary blood-vessels; and its surface is perforated by a great number of oblong holes or small lacunæ of different sizes, the largest lying near the glans.

These lacunæ, or orifices of the excretory ducts of the same number of small glands, are dispersed through the substance of the urethra. Which ducts run for some way in the spongy substance, along the convex side of the internal membrane of the urethra, and open obliquely from behind, forward into the great canal. The edges of the lacunæ are semilunar, or like a crescent.

A little way from the beginning of the cellular substance of the urethra, we meet with two lacunæ more considerable than the rest, and their ducts are very long. These lacunæ and ducts lead to two glandular bodies, situated on the two convex sides of the spongy substance of the urethra near the bulb. Each of them is about the size of a cherry-stone, but they are oblong and flat, and covered intirely by the muscles called *acceleratores*. These two bodies are commonly called *prostate inferiores*.

The cavity of the urethra resembles nearly that of a small writing pen. It is not every where round, and towards the gland becomes broader and flatter on one side, especially in the gland itself, where there is a kind of oval or navicular fossula.

This canal terminates at the extremity of the glans

by a narrow oblong orifice or fissure, which is much less than the rest of the cavity. The commissures of this small fissure are turned one toward the convex, the other toward the flat side of the glans; and the labia of the fissure are its lateral parts; and it seems to be surrounded by fleshy fibres.

The præputium is a continuation of the skin of the pubis and scrotum, and it adheres all the way to the basis of the glans. The rest of the cutaneous integument covers the glans without adhesion, and terminates by an opening. This portion is named præputium, and along the whole lower or back side, both of the whole integument in general, and of the præputium in particular, there runs a fine suture, which is a continuation of the raphe of the perinæum and scrotum.

The inner surface of the præputium is lined with a fine membrane from the opening all the way behind the basis of the glans; and the same membrane is folded from behind, forward, round the glans, forming the proper integument thereof, and covering very closely its whole villous surface, as far as the orifice of the urethra, where it joins the membrane, which lines the inside of that canal.

This proper membrane of the glans, and internal membrane of the præputium, form conjointly along the flat part of the glans, from its basis to the orifice of the urethra, a membranous duplicature, which like a septum or mediastinum divides this part into two lateral portions, and limits the motions of the præputium; for which reason it is called *septum præputii*.

The surface of the internal membrane of the præputium discharges a fluid which prevents it from adhering to the glans.

Several muscles are inserted in the parts which we have described in this paragraph.

The first two muscles are commonly termed *erectores*, or *acceleratores urinæ*. The next two are called *acceleratores*. The four small muscles, two of which are superior, and two inferior, may be called *prostatici*.

The *erectores* lie along the roots of the *corpora cavernosa*; each of them being fixed by one extremity very obliquely, in the internal labium of the ramus of the os ischium, from the tuberosity upward. From thence it accompanies the root of the *corpus cavernosum*, all the way to the symphysis of the ossa pubis, and is fixed by its other extremity in the *corpora cavernosa*, near their union; where the fibres of both bodies meet, and are reciprocally expanded over both corpora. They lie a little lower, and more interiorly, than the roots of these cavernous bodies.

The *musculi transversi*, called also *triangulares*, are two long, narrow, fleshy fasciculi, inserted each by one extremity in the root or beginning of the ramus of the os ischium; from whence they run transversely along the edge of the interosseous ligament of the ossa pubis, as far as the apex of the prostate, where their other extremities meet, and form commonly a kind of digastric muscle, the middle of which gives insertion to the muscles of the urethra, and to the cutaneous sphincters of the anus.

The superior prostatici are two thin planes, fixed in the upper part of the inside of the small rami of the ossa pubis; from whence they are spread over and inserted in the prostates. Their insertions in the ossa pubis are on one side of those of the *obturatores interni*.

The prostatici inferiores are small transverse planes, each of which is fixed in the symphysis, between the ramus of the os pubis and os ischium, and from thence runs transversely, till it meets its fellow from the other side under the prostates, to which they are both strongly connected, and they serve like a girth to sustain these glands.

#### THE PARTS OF GENERATION IN FEMALES.

THE parts of generation in females are several in number, some of them external, and some internal; and they are all subordinate to one principal internal part, called the *uterus*.

The uterus lies between the bladder and intestinum rectum. It is a body inwardly hollow, outwardly of a whitish colour, of a pretty solid substance, and, except in time of pregnancy, of the figure of a flat flask, being in adults about three fingers breadth in length, one in thickness, and two in breadth at one end, and scarcely one at the other.

The broadest portion is termed the *fundus*, and the narrowest the *neck*. Its situation is oblique, the fundus being turned backward and upward, and the neck forward and downward; the broad sides lie next the rectum and bladder, and the narrow sides are lateral.

The cavity of the uterus is flat, and resembles an oblong triangle, the shortest side of which answers exactly to the fundus, and the two longest sides lie one on the right-hand, the other on the left.

Of the three angles of this cavity, the two which terminate the fundus are perforated each by a narrow duct, which with difficulty admits a hog's bristle. The third angle forms a flat duct wider than the former, which perforates the neck of the uterus lengthwise, and terminates at the extremity of that neck by a transverse opening.

This opening is termed the internal orifice of the uterus; and, in the natural state, is narrower than the duct of the *collum uteri*, so that only a small fillet can be passed through it. At the edge of this orifice, are several small holes, answering to the same number of glandular corpuscles, which discharge a viscid lymph.

The inner surface of the cavity of the uterus is lined by a very fine membrane, which at the fundus or broad portion is smooth and even, but in the narrow portion which leads to the orifice it is wrinkled in a particular manner.

The portion of this membrane, which covers the bottom of the cavity, is perforated by a great number of considerable holes, through which small drops of blood may be observed to pass when the whole uterus is compressed.

In the narrow part, which answers to the *collum*, each

side is divided into two lateral parts, by a kind of prominent longitudinal line, which is larger in the upper or anterior side, than in the lower or posterior.

On each side of these two longitudinal lines, there are lines or rugæ obliquely transverse, and disposed like branches, the longitudinal lines representing trunks. Between and round these rugæ, there are small lacunæ, through which a mucilaginous fluid is discharged that closes the orifice of the uterus.

The substance of the body of the uterus is spongy and compact, with a copious intertexture of vessels. Its thickness is nearly equal and uniform in the sides and edges, but the fundus is thicker toward the middle, than toward the two angles, where the thickness decreases gradually. The edges are likewise much thinner near these angles, than near the extremity of the neck.

The uterus is covered by a portion of the peritonæum, which serves it for a coat, and is the continuation of that which covers the bladder and intestinum rectum, running up from the lower and posterior part of the bladder, over the anterior part of the uterus, and from thence over the fundus, and down the backside, and afterwards going to the rectum.

On each lateral part or edge of the uterus, this portion of the peritonæum forms a broad duplicature, which is extended on each side, more or less directly to the neighbouring lateral parts of the pelvis, forming a kind of membranous septum between the anterior and posterior halves of the cavity of the pelvis; and it is afterwards continued in a loose manner with the peritonæum, on the sides of the pelvis.

These two broad duplicatures have the name of *ligamenta lata*, and *vesperitilonum alæ*. The upper edge of each is partly double or folded, forming two small distinct duplicatures.

The laminae of all these duplicatures are connected by a cellular substance, in the same manner as the other duplicatures of the peritonæum; and they contain the Fallopian tubes, the ovaria, a part of the spermatic vessels, and of those that go to the body of the uterus, the ropes called the round ligaments, the nerves, &c.

The ovaria are two whitish, oval, flat, oblong bodies, situated on the sides of the fundus uteri; to which they are fixed by a kind of short round ligament, and inclosed, together with it, in the duplicature of the posterior pinion of the ligamenta lata.

They are composed of a compact spongy substance, and of several little balls, or transparent vesiculæ, which are called *ova*. The spongy substance surrounds each of these vesiculæ very closely, and seems likewise to furnish them with distinct spongy coverings or calices.

The ligaments of the ovaria lie in the edges of the posterior pinions of the ligamenta lata, much in the same manner as the umbilical vein in the anterior or umbilical ligament of the liver: They are round ropes of a filamentary texture, fixed by one extremity to the corner of the fundus uteri, a little above and behind the level of that fundus. They were formerly believed to be hollow, and looked upon as *vasa deferentia*.

The Fallopian tubes are two flaccid, conical and vesiform canals, situated more or less transversely on each

side of the uterus, between the fundus and the lateral parts of the pelvis, and included in the anterior duplicatures or pinions of the ligamenta lata.

Each of them is fixed by its narrow extremities in the corner of the fundus uteri, into which it opens, though by so narrow a duct, as hardly to admit a large bristle. From thence their diameter augments by degrees all the way to the other extremity, where it is about one third part of an inch. The body of the tubæ goes in a winding course, and their large extremity is bent toward the ovaria.

These large extremities are irregularly round, and terminate by a narrow orifice, a little plaited, and turned toward the ovarium, where it presently expands in form of a membranous fringe, full of plaits and incisures. These fringes are called the broad ends of the Fallopian tubes.

These tubes are composed of fleshy fibres, whereof some are longitudinal, and some obliquely circular, with an-intertexture of another very fine substance.

The anterior pinions of the ligamentum latum serve for a common or external coat to both tubæ, and also to connect them, in the same manner as the mesentery connects the intestines. From thence the tubæ, and especially their fringes, come to be loose.

The pubes is that broad eminence at the lower part of the hypogastrium, between the two inguina, on which hairs grow at a certain age. This eminence is owing to a particular thickness of the *membrana adiposa* which covers the fore-part of the ossa pubis, and some small portions of the neighbouring muscles.

The longitudinal cavity which reaches from the middle and lower part of the pubes, within an inch of the anus, was by the ancients termed *sinus*; and they called the lateral parts of that cavity *alæ*, which is a more proper name than that of *labia*, commonly given to them. The places where the alæ are joined above and below are termed commissures; and may likewise be called the extremities or angles of the sinus.

The alæ are more prominent, and thicker above than below, and lie nearer each other below than above. They are chiefly composed of the skin, cellular substance, and fat. The exterior skin is a continuation of that of the pubes and inguina. It is more or less even, and furnished with a great number of glandular corpuscles, from which a whitish ceruminous matter may be expressed; and after a certain age it is likewise covered in the same manner with the pubes.

The inner side of the alæ is something like the red portion of the lips of the mouth; and it is distinguished every where from the external side by a kind of line, in the same manner as the red portion of the lips from the rest of the skin; being likewise thinner and smoother than the outward skin. A great number of pores are observable in it, and also numerous glandular corpuscles which furnish a liquor more or less sebaceous.

Near the inner edge of the inner surfaces of the alæ, on each side of the orifice of the canal of the uterus, we find a small hole more visible than the rest. These two holes are termed lacunæ; and they communicate by two small ducts with the same number of follicular bodies lying;

ing in the substance of the *alæ*, and which may be looked upon as small prostates answering to the glandulæ prostaticæ in males. When compressed, they discharge a viscid liquor.

Above the superior commissure, a thin flat ligament runs down from each small branch of the *ossa pubis*, which penetrates the fat in the substance of each *alæ*, and is lost therein insensibly near the edge. These may be looked upon as the ligamenta suspensoria of the *alæ*. The inferior commissure of the *alæ* is very thin, or like a membranous ligament, and, together with the neighbouring parts of the inner sides, it forms a fossula, termed *navicularis* or *scaphoides*. The space between the inferior commissure and anus, termed *perinæum*, is about a large finger's breadth in length.

The other external parts are situated in the sinus, and hid by the *alæ*. Directly under the superior commissure lies the clitoris, with its covering called *præputium*. A little lower is the orifice of the urethra; and below that is the orifice of the great canal of the uterus. The circumference of this orifice is bordered either by a membranous circle, called *hymen*, or by fleshy portions, termed *carunculæ myrtiformes*. On each side of the clitoris begins a very prominent fold like a *crista*, which runs down obliquely on each side of the orifice of the urethra. These folds are termed *nymphæ*, and they might likewise be named *cristæ clitoridis*.

The clitoris appears at first sight like a small imperforated glans. Its upper and lateral sides are covered by a kind of *præputium*, formed by a particular fold of a portion of the inner side of the *alæ*; which appears to be glandular, and to discharge a certain moisture, and its inside is granulated.

By dissection, we discover in the clitoris a trunk and two branches, as in the penis, made up of a spongy substance, and of very elastic coats, but without any urethra. The trunk is divided into two lateral parts of a middle septum, from the bifurcation, to the glans, where it is insensibly lost.

The bifurcation of the trunk is on the edge of the cartilaginous arch of the *ossa pubis*; and the branches which resemble the roots of the *corpora cavernosa* are inserted in the inferior rami of these bones, and in those of the *ossa ischium*, where they terminate by degrees; but there is sometimes a membranous tube on each side, which reaches to the tuberosity of the *ischium*.

The trunk of the clitoris is sustained by a *ligamentum suspensorium* fixed in the symphysis of the *ossa pubis*, and containing this trunk in its duplicature, nearly as in the other sex.

Four muscles or fasciculi of fleshy fibres are inserted in the trunk of the clitoris, two on each side. One of them runs down on the fore side of the neighbouring *corpus cavernosum*, and is inserted by a tendinous or aponeurotic portion, partly in the extremity of the *corpus cavernosum*, and partly in the tuberosity of the *ischium*. These two muscles are called *erectores*.

The other muscle on each side lies under the former, and runs down on the side of the urethra and great orifice of the uterus, all the way to the anus; increasing gra-

dually in breadth in its passage, and terminating partly like that which is called *accelerator* in males.

These two muscles surround very closely the lateral parts of the urethra, and of the great orifice. They expand very much as they descend, and are spread on the lower and lateral parts of the great orifice; for which reason several anatomists have looked upon them as muscular sphincters.

The *nymphæ*, *cristæ clitoridis*, or, as they may likewise be termed, *alæ minores sive internæ*, are two prominent folds of the inner skin of the great or external *alæ*, reaching from the *præputium* of the clitoris to the two sides of the great orifice of the uterus. They begin very narrow, and, having increased in breadth in their course downward, they are again contracted at their lower extremity.

They are of a spongy substance, intermixed with glands, several of which may be perceived by the naked eye. Their situation is oblique, their upper extremities lying near each other, and the lower at a much greater distance. In married women they are more or less flaccid and decayed.

By the urethra in females, we mean the urinary duct, the orifice of which is between the *nymphæ* below the glans of the clitoris. The sides of this orifice are a little prominent and wrinkled, and perforated by small lacunæ, from which a viscid or mucilaginous liquor may be squeezed.

The body of the urethra is a spongy duct of the same structure as in males, but much shorter, situated directly under the trunk of the clitoris, and above the great canal of the uterus, adhering to each of these canals between which it lies, by membranous filaments. It passes under the cartilaginous arch of the *ossa pubis*, and terminates by an oblique opening at the neck of the bladder.

The great canal is situated below the urethra, and above the extremity of the *intestinum rectum*, a little obliquely, being more raised on the inner and back part, than on the outer and fore part.

Its inner or posterior extremity joins the extremity of the body of the uterus, and surrounds its orifice much in the same manner as the *duodenum* surrounds the *pylorus*, or as the *ilium* is surrounded by the *cæcum* and *colon*.

The anterior extremity forms the great orifice, which lies under that of the urethra, and above the fossula of the inferior commissure of the *alæ*.

The body of the canal is chiefly made up of a spongy substance, interwoven with numerous blood-vessels; and it is commonly longer and narrower in virgins, than in married women.

Its inner or concave surface, has several transverse rugæ, and is covered by a particular membrane. The rugæ are formed by oblong narrow eminences, incusvated like portions of arches, placed very near each other, and disposed in such a manner as to divide the cavity of the canal into an upper and lower side.

By the union of the extremities of the upper and lower rugæ, a kind of raphe or suture is formed on the right and left sides; and both arches are sometimes intersested in the middle, and so form two half-arches.



In general, these arches are very considerable in young persons; become gradually more superficial in married women, and are quite lost in time of delivery.

The inner or posterior extremity of this great canal surrounds the orifice of the uterus, a little obliquely, in such a manner, as that the upper side of the canal lies very near the orifice, and the lower side at a greater distance from it, and this makes the extremity of the uterus appear to advance more into the canal on the lower than on the upper part.

The exterior or anterior extremity of the great canal in virgins, and especially before the first eruption of the menses, is commonly bordered by a circular membranous fold, of different breadths, more or less smooth, and sometimes semilunar, which in some subjects leaves but a very small opening, in others a large opening, and in all renders the external orifice narrower than the rest of the cavity. This fold, called hymen, is formed by the union of the internal membrane of the great canal with that on the inside of the alæ, and represents a membranous circle of different breadths, and sometimes uneven.

This membranous circle is commonly ruptured after the consummation of marriage; is quite lost in delivery; and afterwards only some irregular portions of it remain, which, from their supposed resemblance to myrtle leaves, have been termed *earunculæ myrtiformes*. This circle may likewise suffer some disorder by too great a flux of the menses, by imprudence, levity, and other particular accidents.

Each side of the anterior portion of the great canal is covered exteriorly by a thin broad cavernous and vascular plexus, called the *plexus retiformis* of that canal. These two planes run down on each side of the clitoris behind the nymphæ, and likewise cover the urethra like a collar, before they are spread on the great canal.

This plexus is strictly united to the muscular portions commonly taken for accelerators or constrictors, lying between these portions and the lateral parts of the urethra and of the great canal.

### SECT. III. *Of the Thorax.*

By the thorax, we commonly understand all that part of the body which answers to the extent of the sternum, ribs, and vertebræ of the back, both outwardly and inwardly.

The thorax is divided into the anterior part called commonly the breast, the posterior part called the back, and the lateral parts called the right and left sides.

The external parts of the thorax, besides the skin and *membrana adiposa*, are principally the *mammæ*, and the muscles which cover the ribs and fill the spaces between them. In the *mammæ* we see the *papillæ* or nipples, and a small coloured circle, which surrounds them.

The internal parts of the thorax are contained in the large cavity of that portion of the trunk, called the middle venter, or cavity of the breast. This cavity is lined by a membrane named *pleura*, and divided into two lateral cavities by a membranous septum named *mediastinum*, which is a production or duplicature of the *pleura*.

These parts are the heart, pericardium, trunk of the aorta, a portion of the *aspera arteria* and of the *œsophagus*, the *ductus lacteus* or *thoracicus*, the lungs, &c.

The hard parts, which form the sides of the cavity of the thorax, are the twelve vertebræ of the back, all the ribs, and the sternum. The soft parts, which complete the sides, are the membrane called *pleura*, which lines the cavity, and the *musculi inter-costales*, *sterno-costales*, and *diaphragma*.

All these hard and soft parts taken together represent a kind of cage, in some measure of a conical figure, flattened on the fore-side, depressed on the back-side, and in a manner divided into two nooks by the figure of the vertebræ of the back, and terminated below by a broad arched basis inclined backward. The intercostal muscles fill up the interstices betwixt the ribs, and so complete the sides of the cavity; the basis is the diaphragm, and the *pleura* not only covers the whole inner surface of the cavity, but, by forming the *mediastinum*, divides it into two, one on the right hand, the other on the left.

### M A M M Æ.

THE name of *mammæ*, or breasts, is given to two eminences more or less round, situated in the anterior and a little toward the lateral parts of the thorax.

The body of the *mammæ* is partly glandular, and partly made up of fat; or it is a glandular substance mixed with portions of the *membrana adiposa*, the *cellulous pelliculæ* of which support a great many blood-vessels, lymphatics, and serous or lactiferous ducts, together with small glandular *molliculæ* which depend on the former; all of them being closely surrounded by two membranes continued from the *pelliculæ*.

The innermost of these two membranes, which is in a manner the basis of the body of the *mamma*, is thick and almost flat, adhering to the *musculus pectoralis major*. The second or external membrane is thinner, forming a particular integument for the body of the *mamma*, more or less convex, and adhering closely to the skin.

The *corpus adiposum* of the *mamma* in particular, is a spongy cluster, more or less interlarded with fat, or a collection of membranous *pelliculæ*, which, by the particular disposition of their outer sides, form a kind of membrane in shape of a bag, in which all the rest of the *corpus adiposum* is contained. The anterior or outer portion of this bag, or that which touches the skin, is very thin; but that side next the *pectoralis major*, is thick.

The glandular body contains a white mass, which is merely a collection of membranous ducts, narrow at their origin, broad in the middle, and which contract again as they approach the *papilla*, near which they form a kind of circle of communication. They are named *ductus lactiferi*.

The coloured circle or disk is formed by the skin, the inner surface of which sustains a great number of small glandular *molliculæ*. They appear very plainly all over the *areola*, even on the outside, where they form little flat heights or eminences at different distances quite round the circle.

The tubercle which lies in the center of the areola, is termed papilla, or the nipple. In women with child, or who give suck, it is pretty large, and generally longer or higher than it is thick or broad.

The texture of the nipple is spongy, elastic, and liable to divers changes of consistence, being sometimes harder, sometimes more flaccid. It seems to be made up chiefly of ligamentary fasciculi, the extremities of which form the basis and apex of the nipple.

Between these spongy and elastic fasciculi lie seven or eight particular tubes, at small distances from each other, and all in the same direction. These tubes end at the basis of the papilla in the irregular circle of communication of the lactiferous ducts, and at the apex, in the same number of almost imperceptible holes or orifices.

The use of the mammæ in the nourishment of children is known to all the world: But it is not certainly known what the papillæ and areolæ in males can be designed for. Milk has been observed in them, in children of both sexes.

#### PLEURA AND MEDIASTINUM.

THE pleura is a membrane which adheres very closely to the inner surface of the ribs, sternum, and muscoli inter-costales, sub-costales, and sterno-costales, and to the convex side of the diaphragm. It is of a very firm texture, and plentifully stored with blood-vessels and nerves, in all which it resembles the peritonæum.

The cellular portion goes quite round the inner surface of the thorax, but the membranous portion is disposed in a different manner. Each side of the thorax has its particular pleura, intirely distinct from the other, and making as it were two great bladders, situated laterally with respect to each other in the great cavity of the breast, in such a manner as to form a double septum or partition running between the vertebræ and the sternum, their other sides adhering to the ribs and diaphragm.

This particular duplicature of the two pleuræ is termed mediastinum. The two laminæ of which it is made up are closely united together near the sternum and vertebræ; but in the middle, and toward the lower part of the fore-side, they are separated by the pericardium and heart. A little more backward they are parted in a tubular form by the œsophagus, to which they serve as a covering; and in the most posterior part, a triangular space is left between the vertebræ and the two pleuræ from above downward, which is filled chiefly by the aorta:

The mediastinum does not commonly terminate along the middle of the inside of the sternum, but inclines toward the left side.

The surface of the pleura turned to the cavities of the breast, is continually moistened by a lymphatic serosity which transudes through the pores of the membranous portion.

The pleura serves in general for an inner integument to the cavity of the thorax. The mediastinum cuts off all communication between the two cavities, and hinders one lung from pressing on the other when we lie on one side. It likewise forms receptacles for the heart, pericardium, œsophagus, &c.

#### THYMUS.

THE thymus is an oblong glandular body, round on the upper part, and divided below into two or three lobes, of which that toward the left hand is the longest. In the fœtus it is of a pretty large size, less in children, and very little in aged persons.

The greatest part of the thymus lies between the duplicature of the superior and anterior portion of the mediastinum, and the great vessels of the heart; from whence it reaches a little higher than the tops of the two pleuræ, so that some part of it is out of the cavity of the thorax.

Its particular inward structure and secretions are not as yet sufficiently known to determine its uses, which however seem to be designed more for the fœtus than for adults.

#### C O R.

THE heart is a muscular body situated in the cavity of the thorax on the anterior part of the diaphragm, between the two laminæ of the mediastinum. It is in some measure of a conical figure, flattened on the sides, round at top, and oval at the basis. Accordingly, we consider in the heart the basis, apex, two edges, and two sides, one of which is generally flat, the other more convex.

Besides the muscular body, which chiefly forms what we call the heart, its basis is accompanied by two appendices called auriculæ, and by large blood-vessels; all these are included in a membranous capsula, named pericardium.

It is hollow within, and divided by a septum which runs between the edges into two cavities, called *ventriculi*, one of which is thick and solid, the other thin and soft. This latter is generally termed the right ventricle, the other the left ventricle, though in their natural situation the right ventricle is placed more anteriorly than the left.

Each ventricle opens at the basis by two orifices, one of which answers to the auricles, the other to the mouth of a large artery; and accordingly one of them may be termed the auricular orifice, the other the arterial orifice. The right ventricle opens into the right auricle, and into the trunk of the pulmonary artery; the left, into the left auricle, and into the great trunk of the aorta. At the edges of these orifices are found several moveable pelliculæ, called valves by anatomists; of which some are turned inward, toward the cavity of the ventricles, called triglochines or tricuspides; others are turned towards the great vessels, called femilunares or sigmoidales. The valvulæ tricuspidæ of the left ventricle are likewise termed mitralæ.

The inner surface of the ventricles is very uneven, many eminences and cavities being observable therein. The most considerable eminences are thick fleshy productions called columnæ. To the extremities of these pillars are fastened several tendinous cords, the other ends of which are joined to the valvulæ tricuspidæ. There are likewise other small short tendinous ropes along both edges of the septum between the ventricles. These small cords lie in an obliquely transverse situation, and form a kind of net-work at different distances.

The cavities of the inner surface of the ventricles are small deep fossulæ or lacunæ placed very near each other, with small prominent interstices between them.

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The fleshy or muscular fibres of which the heart is made up, are disposed in a very singular manner, especially those of the right or anterior ventricle, being either bent into arches or folded into angles.

The fibres which are folded into angles are longer than those which are only bent into arches. The middle of these arches, and the angles of the folds, are turned towards the apex of the heart, and the extremities of the fibres towards the basis. These fibres differ not only in length, but in their directions, which are very oblique in all, but much more so in the long or folded fibres than in the short ones, which are simply bent.

Each ventricle is composed of its proper distinct fibres, but the left ventricle has many more than the right. Where the two ventricles are joined, they form a septum which belongs equally to both.

The fibres which compose the inner or concave surface of the ventricles, do not all reach to the basis; some of them running into the cavity, and there forming the fleshy columnæ, to which the loose floating portion of the tricuspidal valves is fastened by tendinous ropes.

The valves at the orifices of the ventricles are of two kinds. One kind allows the blood to enter the heart, and hinders it from going out the same way; the other kind allows the blood to go out of the heart, but hinders it from returning. The valves of the first kind terminate the auricular, and those of the second lie in the openings of the great arteries. The first are termed semilunar or sigmoidal valves, the others triglochines, tricuspidal, or mitral.

The tricuspidal valves of the right ventricle are fixed to its auricular orifice, and turned inward toward the cavity of the ventricle. They are three triangular productions, very smooth and polished on that side which is turned towards the auricle; and on the side next the cavity of the ventricle, they have several membranous and tendinous expansions, and their edges are notched or indented. The valves of the auricular orifice of the left ventricle are of the same shape and structure, but they are only two in number; and from some small resemblance to a mitre, they have been named mitrales.

The semilunar valves are six in number, three belonging to each ventricle; situated at the mouths of the great arteries; and they may be properly enough named *valvæ arteriales*.

The great artery that goes out from the left ventricle, is termed aorta. As it goes out, it turns a little toward the right hand; and then bends obliquely backward to form what is called *aorta descendens*.

The trunk of the artery which goes out from the right ventricle is called *arteria pulmonaris*. This trunk, as it is naturally situated in the thorax, runs first of all directly upward for a small space, then divides laterally into two principal branches, one for each lung; that which goes to the right lung being the longest, for a reason that shall be given hereafter.

The auricles are muscular bags situated at the basis of the heart, one towards the right ventricle, the other towards the left, and joined together by an inner septum, and external communicating fibres, much in the same manner with the ventricles; one of them being named the right auricle, the other the left. They are very uneven

on the inside, but smoother on the outside, and terminate in a narrow, flat, indented edge, representing a cock's comb, or in some measure the ear of a dog. They open into these orifices of each ventricle, which are named auricular orifices; and they are tendinous at their opening, in the same manner as the ventricles.

The right auricle is larger than the left, and it joins the right ventricle by a common tendinous opening. It has two other openings united into one, and formed by two large veins which meet and terminate there, almost in a direct line, called *vena cava superior* and *inferior*. The notched edge of this auricle terminates obliquely in a kind of obtuse point, which is a small particular production of the great bag, and is turned toward the middle of the basis of the heart.

The left auricle is a kind of muscular bag or reservoir, of a pretty considerable thickness, and unequally square, into which the four veins open, called *vena pulmonares*, and which has a distinct appendix belonging to it, like a third small auricle. This bag is very even on both sides.

The heart lies almost transversely on the diaphragm, the greatest part of it being in the left cavity of the thorax, and the apex being turned toward the bony extremity of the sixth true rib. The basis is toward the right cavity; and both auricles, especially the right, rest on the diaphragm.

The origin or basis of the pulmonary artery is, in this natural situation, the highest part of the heart on the fore side; and the trunk of this artery lies in a perpendicular plane, which may be conceived to pass between the sternum and *spina dorsi*. Therefore some part of the basis of the heart is in the right cavity of the thorax; and the rest, all the way to the apex, is in the left cavity; and it is for this reason that the mediastinum is turned toward that side.

According to this true natural situation of the heart, the parts commonly said to be on the right side are rather anterior, and those on the left side posterior; and that side of the heart which is thought to be the fore side, is naturally the upper side, and the back side consequently the lower side.

The lower side is very flat, lying wholly on the diaphragm; but the upper side is a little convex through its whole length, in the direction of the septum between the ventricles.

The heart, with all the parts belonging to it, is contained in a membranous capsula, called *pericardium*, which is in some measure of a conical figure, and much bigger than the heart. It is not fixed to the basis of the heart, but round the large veins above the auricles, before they send off the ramifications, and round the large arteries, before their divisions.

The pericardium is made up of three laminae, the middle and chief of which is composed of very fine tendinous filaments, closely interwoven and crossing each other in different directions. The internal lamina seems to be a continuation of the outer coat of the heart, auricles, and great vessels. The trunks of the aorta and pulmonary artery have one common coat which contains them both as in a sheath, and is lined on the inside by a cellular substance, chiefly in that space which lies between  
where.

where the trunks are turned to each other, and the sides of the sheath. There is but a very small portion of the vena cava contained in the pericardium.

The pericardium is closely connected to the diaphragm, not at the apex, but exactly at that place which answers to the flat or lower side of the heart; and it is a very difficult matter to separate it from the diaphragm in dissection.

The internal lamina is perforated by an infinite number of very small holes, through which a serous fluid continually transudes, in the same manner as in the peritonæum. This fluid being gradually collected after death, makes what is called *aqua pericardii*, which is found in considerable quantities in opening dead bodies while they remain fresh. Sometimes it is of a reddish colour, which may be owing to a transfusion of blood through the fine membrane of the auricles.

The heart and parts belonging to it are the principal instruments of the circulation of the blood. The two ventricles ought to be considered as two syringes so closely joined together as to make but one body, and furnished with suckers placed in contrary directions to each other, so as that by drawing one of them, a fluid is let in, and forced out again by the other.

The heart is made up of a substance capable of contraction and dilatation. When the fleshy fibres of the ventricles are contracted, the two cavities are lessened in an equal and direct manner, not by any contortion or twisting, as the false resemblance of the fibres to a figure of eight has made anatomists imagine. For if we consider attentively in how many different directions; and in how many places, these fibres cross each other, as has been already observed, we must see clearly, that the whole structure tends to make an even, direct, and uniform contraction, more according to the breadth or thickness, than according to the length of the heart, because the number of fibres situated transversely, or almost transversely, is much greater than the number of longitudinal fibres.

The fleshy fibres thus contracted, do the office of suckers, by pressing upon the blood contained in the ventricles, which blood being thus forced toward the basis of the heart, presses the tricuspidal valves against each other, opens the semilunares, and rushes with impetuosity through the arteries and their ramifications, as through so many elastic tubes.

The blood thus pushed on by the contraction of the ventricles, and afterwards pressed by the elastic arteries, enters the capillary vessels, and is from thence forced to return by the veins to the auricles, which, like retirements, porches, or antichambers, receive and lodge the blood returned by the veins during the time of a new contraction. This contraction of the heart is by anatomists termed *systole*.

The contraction or systole of the ventricles ceases immediately, by the relaxation of their fleshy fibres; and in that time the auricles, which contain the venal blood, being contracted, force the blood through the tricuspidal valves into the ventricles, the sides of which are thereby dilated, and their cavities enlarged. This dilatation is termed *diastole*.

In this manner does the heart, by the alternate systole and diastole of its ventricles and auricles, push the blood through the arteries to all the parts of the body, and receive it again by the veins. This is called the circulation of the blood, which is carried on in three different manners.

The first and most universal kind of circulation is that by which almost all the arteries of the body are filled by the systole of the heart, and the greatest part of the veins evacuated by the diastole.

The second kind of circulation opposite to the first, is through the coronary vessels of the heart, the arteries of which are filled with blood during the diastole of the ventricles, and the veins emptied during the systole.

The third kind of circulation is that of the left ventricle of the heart; through the venal ducts of which a small quantity of blood passes, without going through the lungs, which is the course of all the remaining mass of blood.

## PULMONES.

The lungs are two large spongy bodies, of a reddish colour in children, greyish in adult subjects, and bluish in old age; filling the whole cavity of the thorax, one being seated in the right side, the other in the left, parted by the mediastinum and heart, and of a figure answering to that of the cavity which contains them; that is, convex next the ribs, concave next the diaphragm, and irregularly flattened and depressed next the mediastinum and heart.

They are distinguished into the right and left lung; and each of these into two or three portions called *lobi*, of which the right lung has commonly three, or two and a half, and the left lung two. The right lung is generally larger than the left, answerably to that cavity of the breast, and the obliquity of the mediastinum.

At the lower edge of the left lung, there is an indented notch or sinus opposite to the apex of the heart, which is therefore never covered by that lung, even in the strongest inspirations, and consequently the apex of the heart and pericardium may always strike against the ribs.

The substance of the lungs is almost all spongy, being made up of an infinite number of membranous cells, and of different sorts of vessels spread among the cells, in innumerable ramifications.

This whole mass is covered by a membrane continued from each pleura, which is commonly said to be double; but what is looked upon as the inner membrane is only an expansion and continuation of a cellular substance.

The vessels which compose part of the substance of the lungs are of three or four kinds; the air-vessels, blood-vessels, and lymphatics, and the nerves. The air-vessels make the chief part, and are termed *bronchia*.

These bronchia are conical tubes, composed of an infinite number of cartilaginous fragments, like so many irregular arches of circles, connected together by a ligamentary elastic membrane, and disposed in such a manner as that the lower easily insinuate themselves within those above them.

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They are lined on the inside by a very fine membrane, which continually discharges a mucilaginous fluid; and in the substance of the membrane are a great number of small blood-vessels.

The bronchia are divided in all directions into an infinite number of ramifications, which diminish gradually in size; and as they become capillary, change their cartilaginous structure into that of a membrane.

Each of these numerous bronchial tubes is widened at the extremity, and thereby formed into a small membranous cell, commonly called a vesicle. These cells or folliculi are closely connected together in bundles; each small branch producing a bundle proportionable to its extent and the number of its ramifications.

These small vesicular or cellulous bundles are termed *lobules*; and as the great branches are divided into small rami, so the great lobules are divided into several small ones. The cells or vesicles of each lobule have a free communication with each other, but the several lobules do not communicate so readily.

The lobules appear distinctly to be parted by another cellulous substance; which surrounds each of them in proportion to their extent, and fills up the interstices between them. This substance forms likewise a kind of irregular membranous cells, which are thinner, looser, and broader than the bronchial vesicles.

All the bronchial cells are surrounded by a very fine reticular texture of the small extremities of arteries and veins, which communicate every way with each other.

The blood-vessels of the lungs are of two kinds; one common, called the *pulmonary artery* and *veins*; the other proper, called the *bronchial arteries* and *veins*.

The pulmonary artery goes out from the right ventricle of the heart; and its trunk having run almost directly upward as high as the curvature of the aorta, is divided into two lateral branches, one going to the right-hand, called the *right pulmonary artery*, the other to the left, termed the *left pulmonary artery*. The right artery passes under the curvature of the aorta, and is consequently longer than the left. They both run to the lungs, and are dispersed through their whole substance by ramifications nearly like those of the bronchia, and lying in the same directions.

The pulmonary veins having been distributed through the lungs in the same manner, go out on each side, by two great branches, which open laterally into the reservoir or muscular bag of the right auricle.

Besides these capital blood-vessels, there are two others called the *bronchial artery* and *vein*.

Under the root of each lung, that is, under that part formed by the subordinate trunk of the pulmonary artery, by the trunks of the pulmonary veins, and by the trunk of the bronchia, there is a pretty broad membranous ligament, which ties the posterior edge of each lung to the lateral parts of the vertebræ of the back, from that root all the way to the diaphragm.

The bronchia already described are branches or ramifications of a large canal, partly cartilaginous, and partly membranous, called *trachea*, or *aspera arteria*. It is situated anteriorly in the lower part of the neck, from whence it runs down into the thorax betwixt the two

pleura, through the upper space left between the duplication of the mediastinum, behind the thymus.

Having reached as low as the curvature of the aorta, it divides into two lateral parts, one toward the right-hand, the other toward the left, which enter the lungs, and are distributed through them in the manner already said. These two branches are called *bronchia*, and that on the right side is shorter than that of the left.

The trachea is made up of segments of circles or cartilaginous hoops, disposed in such a manner, as to form a canal open on the back part, the cartilages not going quite round; but this opening is filled by a soft glandular membrane, which completes the circumference of the canal.

Each circle is about the twelfth part of an inch in breadth, and about a quarter of that space in thickness. Their extremities are round; and they are situated horizontally above each other, small interstices being left between them, and the lower edge of the superior segments being turned toward the upper edge of those next below them.

They are all connected by a very strong elastic membranous ligament fixed to their edges.

The canal of the *aspera arteria* is lined on the inside by a particular membrane, which appears to be partly fleshy or muscular, and partly ligamentary, perforated by an infinite number of small holes, through which a mucilaginous fluid continually passes, to defend the inner surface of the trachea against the acrimony of the air.

This fluid comes from small glandular bodies dispersed through the substance of the membrane, but especially from the glands, something larger than the former, which lie on the outer or posterior surface of that strong membrane, by which the circumference of the canal is completed. The same structure is observable in the ramifications of the trachea from the greatest to the smallest.

At the angle of the first ramification of the trachea arteria, we find on both the fore and back sides, certain soft, roundish, glandular bodies, of a bluish or blackish colour, and of a texture partly like that of the thymus already described, and partly like that of the glandula thyroidea. There are other glands of the same kind, as the origin of each ramification of the bronchia, but they decrease proportionably in number and size. They are fixed immediately to the bronchia, and covered by the interlobular substance; and they seem to communicate by small openings with the cavity of the bronchia.

Respiration is performed by organs of two kinds, one of which may be looked upon as active, the other as passive. The lungs are of the second kind, and the first comprehends chiefly the diaphragm and intercostal muscles.

As soon as the intercostal muscles begin to contract, the arches of the ribs are raised together with the sternum, and placed at a greater distance from each other; by which means the cavity of the thorax is enlarged on the two lateral and anterior sides.

At the same instant the diaphragm is flatted or brought toward a plane by two motions, which are apparently contrary; that is, by the contraction of the diaphragm, and the dilatation of the ribs in which it is inserted. The external surface of the thorax being thus in a manner increased, and the cavity of the bronchia

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being at the same time, and by the same means, less resisted or pressed upon; the ambient air yields to the external pressure, and insinuates itself into all the places where the pressure is diminished, that is, into the *aspera arteria*, and into all the ramifications of the bronchia all the way to the vesicles. This is what is called *inspiration*.

This motion of inspiration is instantaneous, and ceases in a moment by the relaxation of the intercostal muscles; the elastic ligaments and cartilages of the ribs bringing them back at the same time to their former situation. This motion, by which the ribs are depressed and brought nearer each other, is termed *expiration*.

The pulmonary arteries and veins which accompany the bronchia through all their ramifications, and surround the vesicles, transmit the blood through their narrow capillary extremities, and thereby change or modify it, at least in three different manners.

The first change or modification which the blood undergoes in the lungs, is to have the cohesions of its parts broken, to be attenuated, pounded, and, as it were, reduced to powder. The second is, to be deprived of a certain quantity of serum, which transpires through the lungs, and is what we commonly call the *breath*. The third is to be in a manner reanimated by the impression of the air.

### OESOPHAGUS.

THE *oesophagus* is a canal partly muscular, and partly membranous, situated behind the trachea arteria, and before the vertebræ of the back, from near the middle of the neck, down to the lower part of the thorax; from whence it passes into the abdomen through a particular hole of the small or inferior muscle of the diaphragm, and ends at the upper orifice of the stomach.

It is made up of several coats, almost in the same manner as the stomach, of which it is the continuation. The first coat, while in the thorax, is formed only by the duplicature of the posterior part of the mediastinum, and

is wanting above the thorax and the neck, where the outer coat of the *oesophagus* is only a continuation of the cellular substance belonging to the neighbouring parts.

The second coat is muscular, being made up of several strata of fleshy fibres.

The third is termed the *nervous coat*, and is like that of the stomach and intestines.

The fourth or innermost coat resembles in some measure that of the intestines, except that instead of the villi it has small and very short papillæ. Through the pores of this coat, a viscid lymphæ is continually discharged.

The *oesophagus* from its very beginning, turns a little to the left hand, and naturally runs along the left extremities of the cartilages of the *aspera arteria*. The thyroid gland, pharynx and larynx, shall be described in another place.

### DUCTUS THORACICUS.

THE thoracic duct is a thin transparent canal, which runs up from the receptaculum chyli, along the spina dorsæ, between the vena azygos and aorta, as high as the fifth vertebra of the back, or higher. From thence it passes behind the aorta toward the left hand, and ascends behind the left subclavian vein, where it terminates in some subjects by a kind of vesicula, in others by several branches united together, and opens into the back-side of the subclavian vein near the outside of the internal jugular.

This canal is plentifully furnished with semilunar valves turned upward. Its opening into the subclavian vein in the human body, is, in the place of valves, covered by several pelliculæ, so disposed as to permit the entrance of the chyle into the vein, and hinder the blood from running into the duct. It is sometimes double, one lying on each side, and sometimes it is accompanied by appendices called *pampiniformes*.

## EXPLANATION OF PLATE XIX.

FIGURE 1. Shews the contents of the thorax and abdomen, in situ.

- 1, Top of the trachea, or wind-pipe. 2 2, The internal jugular veins. 3 3, The subclavian veins. 4, The vena cava descendens. 5, The right auricle of the heart. 6, The right ventricle. 7, Part of the left ventricle. 8, The aorta ascendens. 9, The pulmonary artery. 10, The right lung, part of which is cut off to shew the great blood-vessels. 11, The left lung entire. 12 12, The anterior edge of the diaphragm. 13 13, The two great lobes of the liver. 14, The ligamentum rotundum. 15, The gall bladder. 16, The stomach. 17 17, The jejunum and ilium. 18, The spleen.

FIG. 2. Shews the organs subservient to the chylopoetic viscera, — with those of urine and generation.

- 1 1, The under side of the two great lobes of the liver. 2, Lobulus Spigelii. 3, The ligamentum rotundum.

- 3, The gall-bladder. 4, The pancreas. 5, The spleen. 6 6, The kidneys. 7, The aorta descendens. 8, Vena cava ascendens. 9 9, The renal veins covering the arterics. 10, A probe under the spermatic vessels and a bit of the inferior mesenteric artery, and over the ureters. 11 11, The ureters. 12 12, The iliac arteries and veins. 13, The rectum intestinum. 14, The bladder of urine.

FIG. 3. Shews the chylopoetic viscera, and organs subservient to them, taken out of the body intire.

- A A, The under side of the two great lobes of the liver. B, Ligamentum rotundum. C, The gall-bladder. D, Ductus cysticus. E, Ductus hepaticus. F, Ductus communis choledochus. G, Vena portarum. H, Arteria hepatica. I I, The stomach. K K, Venæ & arteriæ gastro-epiploicæ, dextræ & sinistræ. L L, Venæ & arteriæ coronariæ ventriculi. M, The spleen. N N, Mesocolon, with its vessels. O O O, Intestinum

Fig. 1.

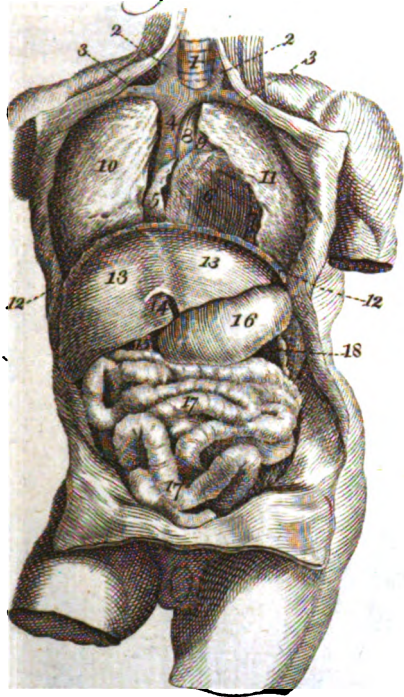


Fig. 2.

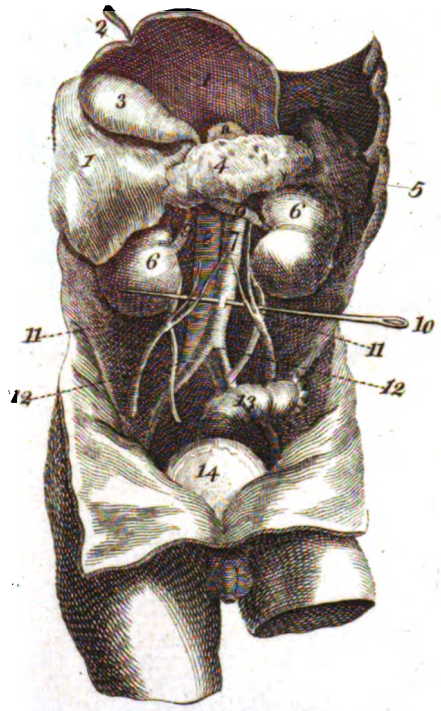


Fig. 3.

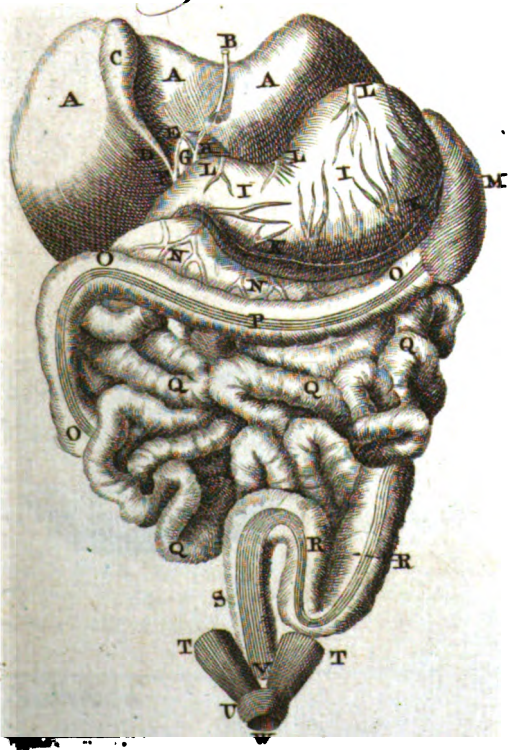


Fig. 4.

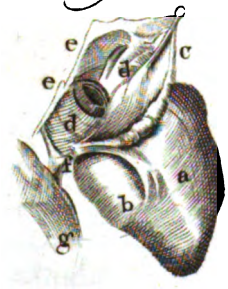
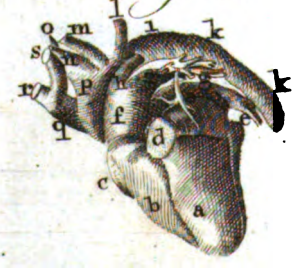


Fig. 5.







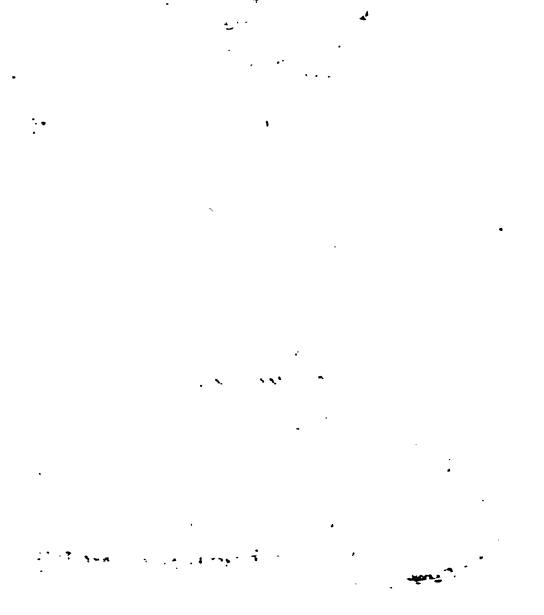
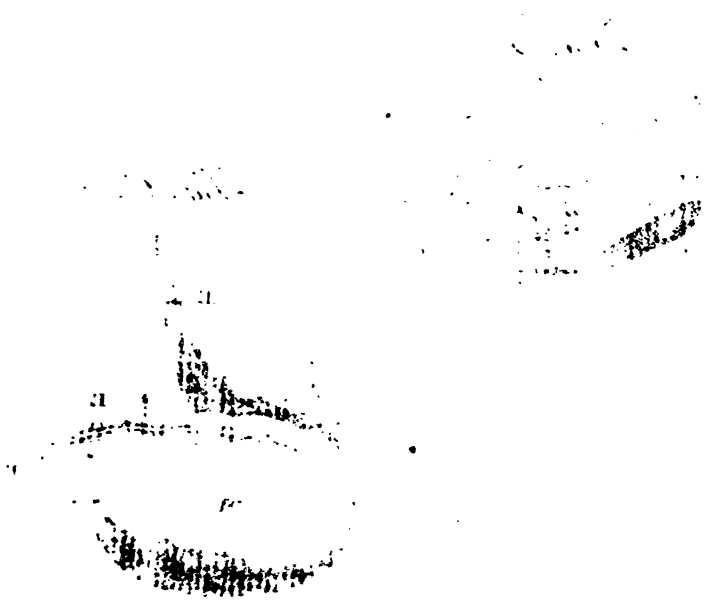
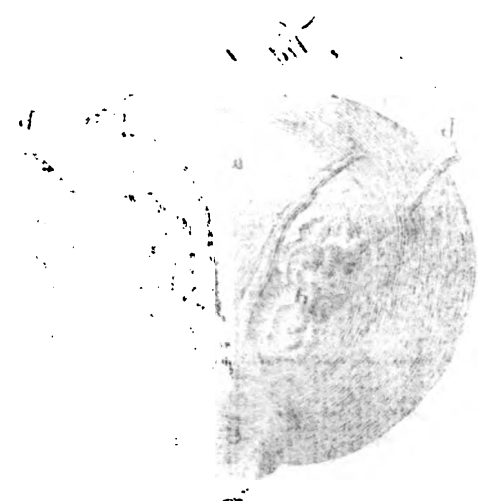


Fig. 1.

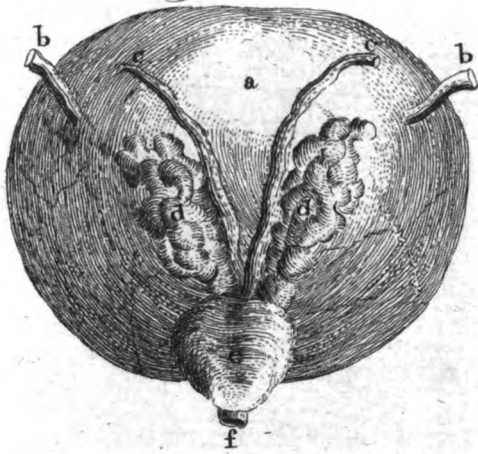


Fig. 4.

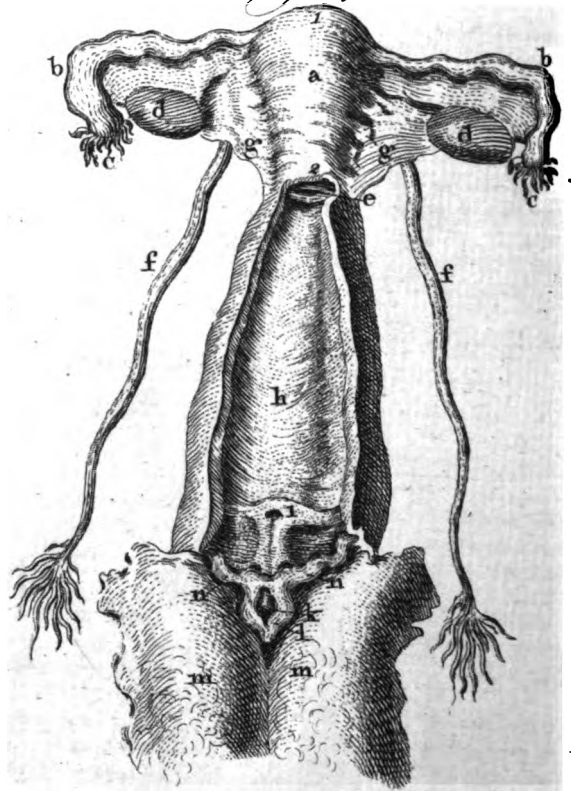


Fig. 2.

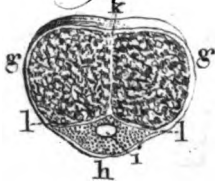


Fig. 5.

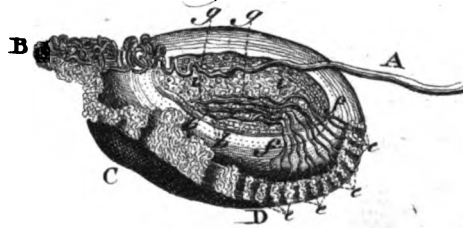


Fig. 3.

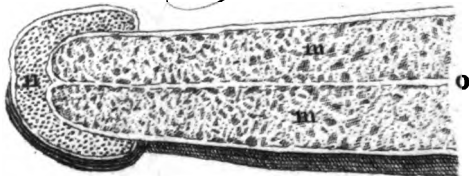
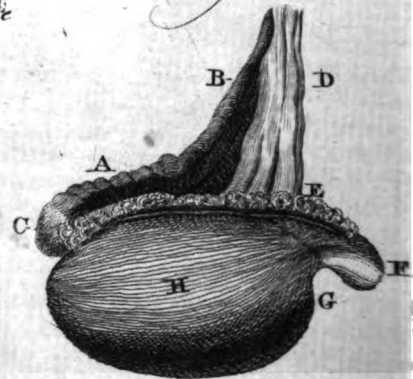


Fig. 6.



A. Bell Sculp.

testisam colon. P, One of the ligaments of the colon, which is a bundle of longitudinal muscular fibres. QQQQ, Jejunum and ilium. RR, Sigmoid flexure of the colon with the ligament continued, and over S, The rectum intestinum. TT, Levatores ani. U, Sphincter ani. V, The place to which the prostate gland is connected. W, The anus.

FIG. 4. Shews the heart of a fœtus at the full time, with the right auricle cut open to shew the foramen ovale; or passage between both auricles.

a, The right ventricle. b, The left ventricle. cc, The outer side of the right auricle stretched out. dd, The posterior side, which forms the anterior side of the septum. e, The foramen ovale, with the membrane or valve which covers the left side. f, Vena cava inferior passing through g, A portion of the diaphragm.

FIG. 5. Shews the heart and large vessels of a fœtus at the full time.

a, The left ventricle. b, The right ventricle. c, A part of the right auricle. d, Left auricle. ee, The right branch of the pulmonary artery. f, Arteria pulmonalis. gg, The left branch of the pulmonary artery, with a number of its largest branches dissected from the lungs. h, The canalis arteriosus. i, The arch of the aorta. kk, The aorta descendens. l, The left subclavian artery. m, The left carotid artery. n, The right carotid artery. o, The right subclavian artery. p, The origin of the right carotid and right subclavian arteries in one common trunk. q, The vena cava superior or descendens. r, The right common subclavian vein. s, The left common subclavian vein.

N. B. All the parts described in this figure are to be found in the adult, except the canalis arteriosus.

## EXPLANATION OF PLATE XX.

FIG. 1. Represents the under and posterior side of the bladder of urine, &c.

a, The bladder. bb, The insertion of the ureters. cc, The vasa deferentia, which convey the semen from the testicles to dd, The vesiculae seminales,—and pass through e, The prostate gland, to discharge themselves into f, The beginning of the urethra.

FIG. 2. A transverse section of the penis.

gg, Corpora cavernosa penis. h, Corpus cavernosum urethrae. i, Urethra. k, Septum penis. ll, The septum between the corpus cavernosum urethrae, and that of the penis.

FIG. 3. A longitudinal section of the penis.

mm, The corpora cavernosa penis, divided by o, The septum penis. n, The corpus cavernosum glandis, which is the continuation of that of the urethra.

FIG. 4. Represents the female organs of generation.

a, That side of the uterus which is next the os sacrum. 1, Its fundus. 2, Its cervix. bb, The Fallopian or uterine tubes, which opens into the cavity of the uterus,—but the other end is open within the pelvis, and surrounded by cc, The fimbriae. dd, The ovaria. e, The os internum uteri, or mouth of the womb. ff, The ligamenta rotunda, which passes without the belly, and is fixed to the labia pudendi. gg, The

cut edges of the ligamenta lata, which connects the uterus to the pelvis. h, The inside of the vagina. i, The orifice of the urethra. k, The clitoris surrounded by (l,) the præputium. mm, The labia pudendi. nn, The nymphæ.

FIG. 5. Shews the spermatic ducts of the testicle filled with mercury.

A, The vas deferens. B, Its beginning, which forms the posterior part of the epididymis. C, The middle of the epididymis, composed of serpentine ducts. D, The head or anterior part of the epididymis unravelled. e e e e, The whole ducts which compose the head of the epididymis unravelled. ff, The vasa efferentia. gg, Rete testis. hh, Some rectilinear ducts which send off the vasa efferentia. ii, The substance of the testicle.

FIG. 6. The right testicle intire, and the epididymis filled with mercury.

A, The beginning of the vas deferens. B, The vas deferens ascending towards the abdomen. C, The posterior part of the epididymis, named globus minor. D, The spermatic vessels inclosed in cellular substance. E, The body of the epididymis. F, Its head, named globus major. G, Its beginning from the testicle. H, The body of the testicle, inclosed in the tunica albuginea.

### SECT. IV. Of the BRAIN and its Appendages.

THE name of brain is given to all that mass which fills the cavity of the cranium, and which is immediately surrounded by two membranes called meninges or *meninges*.

This general mass is divided into three particular portions; the cerebrum or brain properly so called, the cerebellum, and medulla oblongata. To these three parts a fourth is added, which fills the great canal of the spinæ dorsæ, by the name of medulla spiralis; being a continuation of the medulla oblongata.

The

The meninges or membranes are two in number. The first is named *dura mater*; the second *pia mater*, which is again divided into two; the external lamina being termed *arachnoides*, the internal retaining the common name of *pia mater*.

### DURA MATER.

THE *dura mater* incloses the brain and all its appendages. It lines the inside of the cranium, and supplies the place of an internal periosteum, being spread in all the holes and depressions, and covering all the eminences in such a manner as to prevent their being hurtful to the brain.

The *dura mater* is made up of two laminae, adhering very closely together; the fibres of both crossing each other obliquely. Their texture is very close and strong, appearing to be partly ligamentary and partly tendinous.

The *dura mater* sticks closely to the cranium by a great number of filaments of the external lamina, which enter the pores of the bones chiefly at the sutures both above and below; and by penetrating these joints, they communicate with the external periosteum.

These adhesions are formed entirely by the external lamina. The internal lamina is very smooth and polished on the inside, which is also continually moistened by a fine fluid discharged through its pores, much in the same manner as in the peritonæum and pleura.

The folds of the *dura mater* are made by the internal lamina; and three of them form particular septa; one of which is superior, representing a kind of mediastinum between the two great lobes of the brain. The second is in a middle situation, like a diaphragm between the cerebrum and cerebellum; the third is inferior, between the lobes of the cerebellum. The superior septum is longitudinal, in form of a scythe, from whence it is termed the *falx* of the *dura mater*. The middle septum is transverse, and might be called the diaphragm of the brain. The inferior septum is very small, and runs down between the lobes of the cerebellum.

Besides these large folds, there are two small lateral ones on each side of the *fella turcica*, each running from the posterior to the anterior clynoïd apophysis on the same side. These two folds, together with the anterior and posterior parts of the *fella turcica*, form a small fossula in which the pituitary gland is lodged.

The elongations of the *dura mater* are productions of both laminae, which go beyond the general circumference, and pass out of the cranium.

The most considerable of these elongations passes through the great occipital foramen, and runs down the common canal of the vertebrae in form of a tube, lining the inside of that canal, and inclosing the *medulla spinalis*, by the name of the *dura mater* of that *medulla*. The other elongations accompany the nerves out of the cranium in form of vaginae, which are more numerous than the nervous trunks reckoned in pairs.

There are two particular elongations which form the peristoneum of the orbits, together with the vaginae of the optic nerves. These orbital elongations go out by the sphenoidal or superior orbital fissures, and, increas-

ing in breadth in their passage, line the whole cavity of the orbits, at the edges of which they communicate with the pericranium and periosteum of the face.

The elongations of the *dura mater* which accompany the blood-vessels through the foramina of the cranium, unite with the pericranium immediately afterwards. Such, for instance, are the elongations which line the fossulae of the foramina lacera or jugularia, and the bony or carotid canals of the apophysis petrosa, &c.

The *dura mater* contains in its duplicature several particular canals, into which the venal blood not only of that membrane, but of the whole brain, is carried. These canals are termed sinuses, and some of them are disposed in pairs, others in uneven numbers; that is, some of them are placed alone, in a middle situation; others are disposed laterally on each side of the brain. The most ancient anatomists reckoned only four; to which we can now add four times as many.

These sinuses are in the duplicature of the *dura mater*; and their cavities are lined on the inside by particular very fine membranes. They may be enumerated in this manner.

The great sinus of the *falx*, or superior longitudinal sinus, which was reckoned the first by the ancients.

Two great lateral sinuses, the second and third of the ancients.

The sinus called *torcular Herophili*, the fourth of the ancients.

The small sinus of the *falx*, or inferior longitudinal sinus.

The posterior occipital sinus, which is sometimes double.

Two inferior occipital sinuses, which form a portion of a circle, and may likewise be called the *inferior lateral sinuses*.

Six sinus petrosi, three on each side, one anterior; one middle or angular, and one inferior. The two inferior, together with the occipital sinuses, complete a circular sinus round the great foramen of the os occipitis.

The inferior transverse sinus.

The superior transverse sinus.

The two circular sinuses of the *fella sphenoidalis*; one superior, and one inferior.

Two sinus cavernosi, one on each side.

Two orbital sinuses, one on each side.

All these sinuses communicate with each other, and with the great lateral sinuses by which they discharge themselves into the internal jugular veins, which are only continuations of these lateral sinuses. They likewise unload themselves partly into the vertebral veins, which communicate with the small lateral or inferior occipital sinuses; and partly into the external jugular veins, by the orbital sinuses which communicate with the venae angulares, frontales, nasales, maxillares, &c. as the lateral sinuses likewise communicate with the venae occipitales, &c.

Thus the blood which is carried to the *dura mater*, &c. by the external and internal carotid, and by the vertebral arteries, is returned to the heart by the external and internal jugular and vertebral veins; so that when the passage of the blood is obstructed in any particular place, it finds another way, by virtue of these communications, though not with the same ease.

## PIA MATER.

THIS membrane surrounds the whole mass of the brain more particularly than the dura mater. It adheres very closely to the brain, and is connected to the dura mater only by the veins which open into the sinuses.

The pia mater is made up of two very fine laminae, the outermost of which covers pretty uniformly all the convex surface of the brain, and lines in the same manner all the concave or inner surface of the dura mater. The internal lamina forms a great number of plicae, duplicatures, and septa, which insinuate themselves into all the folds and circumvolutions, and between the different strata of the cerebrum and cerebellum.

## CEREBRUM.

THE cerebrum properly so called, is a kind of medullary mass, of a moderate consistence, and of a greyish colour on the outer surface, filling all the superior portion of the cavity of the cranium, or that portion which lies above the transverse septum. The upper part of the cerebrum is of an oval figure, like half an egg cut lengthwise. It is flattened on the lower part, each lateral half of which is divided into three eminences, called lobes, one anterior, one middle, and one posterior.

The substance of the cerebrum is of two kinds, distinguished by two different colours; one part of it, which is softest, being of a greyish or ash colour; the other, which is more solid, being very white. The ash-coloured substance lies chiefly on the outer part of the cerebrum like a kind of cortex, from whence it has been named *substantia corticalis* or *cinerea*. The white substance occupies the inner part, and is named *substantia medullaris*, or simply *substantia alba*.

The cerebrum is divided into two lateral portions, separated by the falx, or great longitudinal septum of the dura mater. They are generally termed hemispheres. Each of these portions is divided into two extremities, one anterior and one posterior, which are termed the lobes of the cerebrum, between which there is a large inferior protuberance which goes by the same name; so that in each hemisphere there are three lobes, one anterior, one middle, and one posterior.

The anterior lie upon these parts of the os frontis which contribute to the formation of the orbits and of the frontal sinuses, commonly called the anterior fossae of the basis cranii. The posterior lobes lie on the transverse septum; and the middle lobes, in the middle or lateral fossae of the basis cranii.

Each lateral portion of the cerebrum has three sides; one superior, which is convex; one inferior, which is uneven; and one lateral, which is flat, and turned to the falx. Through the whole surface of these three sides we see inequalities or windings like the circumvolutions of intestines, formed by waving streaks or furrows very deep and narrow, into which the septa or duplicatures of the pia mater insinuate themselves, and thereby separate these circumvolutions from each other.

Near the surface these circumvolutions are at some dis-

stance from each other, representing serpentine ridges; and in the interstices between them, the superficial veins of the cerebrum are lodged, between the two laminae of the pia mater, from whence they pass in the duplicatures of the dura mater, and so open into the sinuses.

These circumvolutions are fixed through their whole depth to the septa or duplicatures of the pia mater, by an infinite number of very fine vascular filaments,

When they are cut transversely, we observe that the *substantia alba* lies in the middle of each circumvolution, so that there is the same number of internal medullary circumvolutions as of external cortical ones.

Having cut off the falx from the crista galli, and turned it backward; if we separate gently the two lateral parts or hemispheres of the cerebrum, we see a longitudinal portion of a white convex body, which is named corpus callosum. It is a middle portion of the medullary substance, which under the inferior sinus of the falx, and also a little toward each side, is parted from the mass of the cerebrum, to which it is simply contiguous from one end of that sinus to the other.

The surface of the corpus callosum is covered by the pia mater, which runs in between the lateral portions of this body, and the lower edge of each hemisphere.

The corpus callosum becomes afterwards continuous on each side with the medullary substance, which through all the remaining parts of its extent is intirely united with the cortical substance, and together with the corpus callosum forms a medullary arch or vault of an oblong or oval figure. After which we will observe a medullary convexity much smaller than that which is common to the whole cerebrum, but of the same form; so that it appears like a medullary nucleus of the cerebrum.

Under this arch are two lateral cavities, much longer than they are broad, and very shallow, separated by a transparent medullary septum. These cavities are named the anterior, superior, or great lateral ventricles of the cerebrum.

The lateral ventricles are broad, and rounded at these extremities which lie next the transparent septum. They go from before backward, contracting in breadth, and separating from each other gradually in their progress. Afterwards they bend downward, and return obliquely from behind forward, in a course like the turning of a ram's horn, and terminate almost under their superior extremities. These ventricles are lined with a thin membrane.

The transparent partition or septum lucidum, lies directly under the raphe or suture of the corpus callosum, of which it is a continuation. It is made up of two medullary laminae, more or less separated from each other by a narrow medullary cavity, sometimes filled with a serous substance.

The septum lucidum is united by its lower part, to the anterior portion of that medullary body, called the *for-nix with three pillars*.

The fornix being cut off and inverted, or quite removed, we see first of all a vascular web, called *plexus choroides*, and several eminences more or less covered by the expansion of that plexus. There are four pairs of eminences

eminences which follow each other very regularly, two large, and two small. The first two great eminences are named *corpora striata*; and the second, *thalami nervorum opti-  
corum*. The four small eminences are closely united together; the anterior being called *nates*, and the posterior *testes*. Immediately before these tubercles there is a single eminence, called *glandula pinealis*.

The *corpora striata* got that name, because in scraping them with the knife we meet with a great number of white and ash-coloured lines alternately disposed, which are only the transverse section of the medullary and cortical laminæ, mixed together in a vertical position in the basis of the cerebrum.

They lie in the bottom of the superior cavity of the lateral ventricles, which they resemble in some measure in shape, their anterior parts being near the septum lucidum, from which they separate gradually as they run backward, and diminish in size.

The *thalami nervorum opti-  
corum* are so named, because these nerves arise chiefly from them. They are two large eminences placed by the side of each other, between the posterior portions or extremities of the *corpora striata*. Their figure is semi-spheroidal and a little oval; and they are of a whitish colour on the surface; but their inner substance is partly greyish and partly white.

These two eminences are closely joined together, and at their convex part they are so far united as really to become one body, the whitish outer substance being continued uniformly over them both.

Immediately within this whitish common substance these two eminences are closely contiguous till about the middle of their thickness; and from thence they separate insensibly toward the bottom, where by the space left between them a particular canal is formed, named the third ventricle, one extremity of which opens forward, the other backward.

At the bottom these two eminences are elongated downward toward both sides, into two thick, round, whitish cords, which separate from each other like horns, by a large curvature; and afterwards by a small curvature turned forward in an opposite direction to the former, and representing the tip of an horn, they approach each other again. The size of these ropes diminishes gradually from their origin to their anterior reunion.

The tubercles are four in number, two anterior, and two posterior; adhering together as if they made but one body, situated behind the union of the *thalami nervorum opti-  
corum*. Their surface is white, and their inner substance greyish, and are called *nates* and *testes*.

Directly under the place where the tubercles of one side are united to those of the other side, lies a small middle canal, which communicates by its anterior opening with the third ventricle, under the *thalami nervorum opti-  
corum*, and by its posterior opening with the fourth ventricle, which belongs to the cerebellum.

Where the convex parts of the two anterior tubercles join these posterior convex parts of the *thalami nervorum opti-  
corum*, an interstice or opening is left between these four convexities which communicates with the third ventricle, and with the small middle canal. Instead of the

ridiculous name of *anus*, which has been given to this opening, it may be called *foramen commune posterius*.

The *glandula pinealis* is a small soft greyish body, about the size of an ordinary pea, irregularly round, and sometimes of the figure of a pine apple, situated behind the *thalami nervorum opti-  
corum*, above the tubercula quadrigemina. It is fixed like a small button to the lower part of the thalami by two very white medullary pedunculi, which at the gland are very near each other, but separate almost transversely toward the thalami.

It seems to be mostly of a cortical substance, except near the footstalks, where it is something medullary.

Between the basis of the anterior pillar of the fornix, and the anterior part of the union of the optic thalami, lies a cavity or fossula named *infundibulum*. It runs down towards the basis of the cerebrum, contracting gradually, and terminates in a straight course, by a small membranous canal, in a softish body situated in the sella turcica, named *glandula pituitaria*. The *infundibulum* opens above, immediately before the optic thalami, by an oval hole named *foramen commune anterius*, and consequently communicates with the lateral ventricles.

At the lower part of the *thalami nervorum opti-  
corum*, directly under their union, lies a particular canal, called the *third ventricle* of the cerebrum.

This canal opens forward into the *infundibulum* under the *foramen commune anterius*, by which it likewise communicates with the lateral ventricles. It opens backward under the *foramen commune posterius*, between the thalami and tubercula quadrigemina, opposite to the small middle canal which goes to the cerebellum.

The plexus choroides is a very fine vascular texture, consisting of a great number of arterial and venal ramifications, partly collected in two loose fasciculi, which lie one in each lateral ventricle, and partly expanded over the neighbouring parts, and covering in a particular manner the *thalami nervorum opti-  
corum*, *glandula pinealis*, tubercula quadrigemina, and the other adjacent parts both of the cerebrum and cerebellum, to all which it adheres.

The pituitary gland is a small spongy body lodged in the sella turcica between the sphenoidal folds of the dura mater. It is of a singular kind of substance, which seems to be neither medullary nor glandular. On the outside it is partly greyish and partly reddish, and white within. It is transversely oval or oblong, and on the lower part in some subjects it is divided by a small notch into two lobes, like a kidney-bean. It is covered by the pia mater as by a bag, the opening of which is the extremity of the *infundibulum*, and it is surrounded by the small circular sinuses which communicate with the sinus cavernosi.

## CEREBELLUM.

The cerebellum is contained under the transverse septum of the dura mater. It is broader laterally than on the fore or back sides, flattened on the upper side, and gently inclined both ways, answerable to the septum, which serves it as a kind of tent or ceiling. On the lower side it is rounder; and on the backside it is divided into

into two lobes, separated by the occipital septum of the dura mater.

It is made up, like the cerebrum, of two substances, but it has no circumvolutions on its surface. Its sulci are pretty deep, and disposed in such a manner as to form thin flat strata, more or less horizontal, between which the internal lamina of the pia mater insinuates itself by a number of septa equal to that of the strata.

Under the transverse septum, it is covered by a vascular texture, which communicates with the plexus choroïdes. It has two middle eminences called *appendices vermiformes*; one anterior and superior, which is turned forward; the other posterior and inferior, which goes backward. There are likewise two lateral appendices, both turned outward.

Besides the division of the cerebellum into lateral portions or into two lobes, each of these lobes seems to be likewise subdivided into three protuberances, one anterior, one middle or lateral, and one posterior.

When we separate the two lateral portions or lobes, having first made a pretty deep incision, we discover first of all the posterior portion of the medulla oblongata; and in the posterior surface of this portion, from the tubercula quadrigemina, all the way to the posterior notch in the body of the cerebellum, and a little below that notch, we observe an oblong cavity which terminates backward like the point of a writing pen. This cavity is what is called the fourth ventricle.

At the beginning of this cavity, immediately behind the small common canal which lies under the tubercles, we meet with a thin medullary lamina, which is looked upon as a valve between that canal and the fourth ventricle. A little behind this lamina, the cavity grows wider towards both hands, and then contracts again to its first size. It is lined interiorly by a thin membrane, and seems oftentimes to be distinguished into two lateral parts, by a kind of small groove, from the valvular lamina to the point of the calamus scriptorius.

This membrane is a continuation of that which lines the small canal, the third ventricle, infundibulum, and the two great ventricles.

On each side of this ventricle the medullary substance forms a trunk which expands itself in form of laminae through the cortical strata. When one lobe of the cerebellum is cut vertically from above downward, the medullary substance will appear to be dispersed in ramifications through the cortical substance. These ramifications have been named *arbor vitæ*; and the two trunks from whence these different laminae arise, are called *pedunculi cerebelli*.

### MEDULLA OBLONGATA.

THE medulla oblongata is a medullary substance situated from before backward in the middle part of the bases of the cerebrum and cerebellum without any discontinuation, between the lateral parts of both these bases; and therefore it may be looked upon as one middle medullary basis common to both cerebrum and cerebellum, by the reciprocal continuity of their medullary substances, through the great notch in the transverse septum of the

dura mater; which common basis lies immediately on that portion of the dura mater which lines the basis of the cranium. The medulla oblongata is therefore justly esteemed to be a third general part of the whole mass of the brain, or as the common production or united elongation of the whole medullary substance of the cerebrum and cerebellum.

It is extremely difficult, if not altogether impossible, to examine or demonstrate it as we ought, in its natural situation; but we are obliged to do both on a brain inverted.

The lower side of the medulla oblongata in an inverted situation, presents to our view several parts which are in general either medullary productions, trunks of nerves, or trunks of blood-vessels.

The chief medullary productions are these: The large or anterior branches of the medulla oblongata; which have likewise been named *crura anteriora*, *femora*, and *brachia medullæ oblongatæ*, and *pedunculi cerebri*: The transverse protuberance, called likewise *processus annularis*, or *pons varolii*: The small or posterior branches, called *pedunculi cerebelli*, or *crura posteriora medullæ oblongatæ*: The extremity or cauda of the medulla oblongata; with two pairs of tubercles, one of which is named *corpora olivaria*, the other *corpora pyramidalia*; and to all these productions we must add a production of the infundibulum and two medullary papillæ.

The great branches of the medulla oblongata are two very considerable medullary fasciculi, the anterior extremities of which are separated, and the posterior united, so that, taken both together, they represent a Roman V.

The transverse, annular, or rather semi-annular protuberance, is a medullary production, which seems at first sight to surround the posterior extremities of the great branches; but the medullary substance of this protuberance is in reality intimately mixed with that of the two former. Varolius, an ancient Italian author, viewing those parts in an inverted situation, compared the two branches to two rivers, and the protuberance to a bridge over them both, and from thence it has the name of *pons Varolii*.

The small branches of the medulla oblongata are lateral productions of the transverse protuberance, which by their roots seem to encompass that medullary portion in which the fourth ventricle or calamus scriptorius is formed.

The extremity is no more than the medulla oblongata contracted in its passage backward to the anterior edge of the great foramen of the os occipitis, where it terminates in the medulla spinalis; and in this part of it several things are to be taken notice of. We see first of all, four eminences, two named *corpora olivaria*, and the other two *corpora pyramidalia*. Immediately afterwards, it is divided into two lateral portions by two narrow grooves, one on the upper side, the other on the lower. They both run into the substance of the medulla, as between two cylinders, flattened on that side by which they are joined together.

When we separate these ridges with the fingers, we observe a crucial intertexture of several small medullary cords.

cords, which go obliquely from the substance of one lateral portion into the substance of the other.

The corpora olivaria and pyramidalia are whitish eminences situated longitudinally near each other on the lower side of the extremity or cauda, immediately behind the transverse or annular protuberances. The corpora olivaria are in the middle, so that the interstice between them, which is a kind of superficial groove, answers to the inferior groove of the following portion.

The corpora pyramidalia are two lateral eminences depending on the olivaria. These four eminences are situated on the lower half of the medulla.

The tubercula mammillaria, or papillæ medullares, which are situated very near the production of the infundibulum, have been taken for glands.

These tubercles seem to have some immediate relation to the roots or bases of the anterior pillar of the fornix.

The beak or tube of the infundibulum is a very thin production from the sides of that cavity; and it is strengthened by a particular coat given to it by the pia mater. It is bent a little from behind forward, toward the glandula pinealis, and afterwards expands again round this gland.

The membrana arachnoides, or external lamina of the pia mater, appears to be very distinctly separated from the internal lamina, in the interstices between all these eminences on the lower side of the medulla oblongata, without any visible cellular substance between them.

From this medulla oblongata, arise almost all the nerves which go out of the cranium through the different foramina by which its basis is perforated. It likewise produces the medulla spinalis, which is no more than a common elongation of the cerebrum and cerebellum, and of their different substances; and therefore the medulla oblongata may justly be said to be the first origin or primitive source of all the nerves of the human body.

## MEDULLA SPINALIS.

THE medulla spinalis is only an elongation of the extremity of the medulla oblongata; and it has its name from its being contained in the bony canal of the spina dorsæ; consequently a continuation or common appendix of the cerebrum or cerebellum, as well because of the two substances of which it is composed, as because of the membranes by which it is invested.

The dura mater, after it has lined the whole internal surface of the cranium, goes out by the great occipital foramen, and forms a kind of funnel, in its progress downward through the bony canal of the vertebræ.

The spinal marrow is made up of a cortical and medullary substance, as the cerebrum and cerebellum; but with this difference, that the ash-coloured substance lies within the other; and in a transverse section of this medulla, the inner substance appears to be of the figure of an horse-shoe.

The body of the medulla spinalis runs down all the way to the first vertebra of the loins, where it terminates in a point. The size of it is proportionable to that of

the bony canal, so that it is larger in the vertebræ of the neck than those of the back.

It sends off from both the fore and back sides, at different distances, flat fasciculi of nervous filaments. The anterior and posterior fasciculi having got a little beyond the edge of the medulla, unite in pairs, and form on each side a kind of knots, called *ganglions* by anatomists, each of which produces a nervous trunk. These ganglions are made up of a mixture of cortical and medullary substance, accompanied by a great number of small blood-vessels.

The dura mater, which invests the medulla, sends out on each side the same number of vaginæ as there are ganglions and nervous trunks. These vaginæ are productions of the external lamina; the internal lamina, which is very smooth and polished on the inside, being perforated by two small holes very near each other, where each vagina goes off, through which holes the extremities of each anterior and posterior fasciculus are transmitted; and immediately after their passage through the internal lamina, they unite.

### USES of the BRAIN and its Appendages in general.

MALPHIGHI was the first who discovered the brain to be a gland, or an organ fitted to separate some particular fluid from the mass of blood.

The infinite number of small secretory clusters strain or filter the mass of blood carried to them by the numerous ramifications, and separate from it an excessively fine fluid; the remaining blood being conveyed back by the same number of venal extremities, into the sinuses of the dura mater, and from thence into the jugular and vertebral veins.

This subtle fluid, commonly called *animal spirit*, *nervous juice*, or *liquor of the nerves*, is continually forced into the medullary fibres of the white portion of the cerebrum, cerebellum, medulla oblongata, and medulla spinalis; and by the intervention of these fibres supplies and fills the nerves, which are a continuation of them.

## PERICRANIUM.

BESIDES the external integuments of the head, the skin, hair, and cellular substance, there is an aponeurotic expansion which covers the head like a cap, and is spread round the neck and on the shoulders like a riding-hood.

This aponeurosis is very strong on the head, and it appears to be made up at least of two strata of fibres crossing each other. As it is spread on the neck it becomes gradually thinner, and ends insensibly on the clavicles. It sends out a production on each side, from above downward, and from without inward, which having passed over the superior extremity of the musculus sterno-mastoideus, runs behind that muscle toward the transverse apophyses of the vertebræ of the neck, where it communicates with the ligamenta inter-transversalia.

The external surface of all the bones of the head, as well



well as of all the other bones of the human body, except the teeth, is covered by a particular membrane, of which that portion which particularly invests the cranium is named *pericranium*, and that which invests the bones of the face is simply termed *periosteum*.

The *pericranium* is made up of two laminae closely united together. The internal lamina, which has by some been taken for a particular *periosteum*, covers immediately all the bony parts of this region; and the external lamina has been looked upon as a membrane distinct from the internal, and named *pericranium* particularly.

### SECT. V. Of the EYE.

#### The GLOBE or BALL of the EYE.

THE globe of the eye is made up of several proper parts, some of which being more or less solid, represent a kind of shell formed by the union of several membranous strata called the *coats* of the globe of the eye; and the other parts being more or less fluid, and contained in particular membranous capsules, or in the interstices between the coats, are termed the *humours* of the globe of the eye. These capsules are likewise termed *coats*.

The coats of the globe of the eye are of three kinds. Some form chiefly the shell of the globe; some are additional, being fixed only to a part of the globe; and some are capsular, which contain the humours. The coats which form the shell are three in number. The external is termed *tunica sclerotica* or *cornea*; the middle coat is named *choroides*; and the third or innermost, *retina*. The additional coats are two; one called *tendinosa* or *albuginea*, which forms the white of the eye; and the other, *conjunctiva*. The capsular tunicae are likewise two, the vitreæ, and crystallina.

#### The COATS of the EYE.

THE most external, thickest, and strongest coat of the eye is the *sclerotica* or *cornea*, and it invests all the other parts of which the globe is composed. It is divided into two portions, one called *cornea opaca*, the other *cornea lucida*, which is only a small segment of a sphere, situated anteriorly.

The *cornea opaca* is made up of several strata closely connected together, and is of an hard compact texture resembling parchment. About the middle of its posterior convex portion, where it sustains the optic nerve, it is in a manner perforated, and thicker than any where else.

The *cornea lucida* is made up in the like manner of several strata or laminae closely united, and appears to be a continuation of the opaque portion or *sclerotica*, though of a different texture.

This portion is something more convex than the *cornea opaca*, so that it represents the segment of a small sphere added to the segment of a greater.

The *cornea lucida* is perforated by a great number of imperceptible pores, through which a very fine fluid is continually discharged, which soon afterwards evaporates.

The second coat of the globe of the eye is the cho-

roides, which is of a blackish colour, more or less inclined to red, and adheres, by means of a great number of small vessels, to the *cornea opaca*, from the insertion of the optic nerve, all the way to the union of the two *cornæ*, where it leaves the circumference of the globe, and forms a perforated septum, by which the small segment of the globe is separated from the greater. This portion goes commonly by the particular name of *uvea*; which was formerly given to the whole second coat; and as it is of different colours in several subjects, it has likewise got the name of *iris*.

The anterior portion or perforated septum of the *choroides* has the name of *uvea*, and the hole near the centre of this septum is called *pupilla*. The anterior lamina of the same septum is termed *iris*, and the radiated plicæ of the posterior lamina, *processus ciliares*. Between the two laminae of the *uvea*, we find two very thin planes of fibres which appear to be fleshy, the fibres of one plane being orbicular, and lying round the circumference of the *pupilla*, and those of the other being radiated, one extremity of which is fixed to the orbicular plane, the other to the great edge of the *uvea*.

The plicæ or *processus ciliares* are small radiated and prominent duplicatures of the posterior lamina of the *uvea*, and their circumference answers partly to that of the white ring of the external lamina. They are oblong thin plates; their posterior extremities, or those next the *choroides*, being very fine and pointed; the others, or those next the *pupilla*, broad, prominent, and ending in acute angles.

The space between the *cornea lucida* and *uvea* contains the greatest part of the aqueous humour, and communicates by the *pupilla* with a very narrow space behind the *uvea*, or between that and the crystalline. These two spaces have been termed the two chambers of the aqueous humour, one anterior, the other posterior.

The third coat of the eye is of a very different texture from that of the other two coats. It is white, soft, and tender, and in a manner medullary, or like a kind of paste spread upon a fine reticular web. It appears to be thicker than the *choroides*, and reaches from the insertion of the optic nerve, to the extremities of the ciliary radii, being equally fixed to the *choroides* through its whole extent. At the place which answers to the insertion of the optic nerve, we observe a small depression, in which lies a sort of medullary button terminating in a point; and from this depression blood-vessels go out, which are ramified on all sides through the substance of the retina.

#### The HUMOURS of the EYE and their CAPSULE.

The vitreous humour is a clear and very liquid gelatinous fluid, contained in a fine transparent capsule, called *tunica vitrea*, together with which it forms a mass nearly of the consistence of the white of an egg. It fills the greatest part of the globe of the eye, that is, almost all that space which answers to the extent of the retina, except a small portion behind the *uvea*, where it forms a fossula, in which the crystalline is lodged.

The *tunica vitrea* is composed exteriorly of two lami-

are very closely connected, which quite surround the mass of humour, and are immediately applied to the retina; all the way to the great circumference of the corona ciliaris; but from thence to the circular edge of the fossula of the crystalline, this coat is full of radiated sulci, which contain the processus ciliares of the uvea.

The internal lamina of the tunica vitrea gives off, through the whole substance of this humour, a great number of cellular elongations or septa.

The radiated sulci of the tunica vitrea, which may be termed *sulci ciliares*, are perfectly black, when the coat is taken out of the body.

The crystalline is a small lenticular body, of a pretty firm consistence, and transparent like crystal. It is contained in a transparent membranous capsula, and lodged in the anterior fossula of the vitreous humour.

The figure of the crystalline is lenticular, but its posterior side is more convex than the anterior, the convexity of both sides being very rarely equal.

The crystalline capsula or coat is formed by a duplication of the tunica vitrea. The external lamina covers the anterior side of the crystalline mass; the internal lamina covers the backside, and likewise the fossula vitrea, in which the crystalline is lodged.

The anterior portion swells when macerated in water, and then appears to be made up of two pelliculæ, united by a fine spongy substance.

The aqueous humour is a very limpid fluid, resembling a kind of lymph or serum, with a very small degree of viscosity; and it has no particular capsula like the crystalline and vitreous humours. It fills the space between the cornea lucida and uvea, that between the uvea and the crystalline, and the hole of the pupilla. These two spaces are called the chambers of the aqueous humour, and they are distinguished into the anterior and posterior.

The anterior chamber, which is visible to every body, between the cornea lucida and uvea, is the largest; the other between the uvea and crystalline is very narrow, especially near the pupilla, where the uvea almost touches the crystalline.

#### *The TUNICA ALBUGINEA and MUSCLES of the GLOBE of the EYE.*

THE tunica albuginea, called commonly the *white of the eye*, and which appears on all the anterior convex side of the globe, from the cornea lucida, to the beginning of the posterior side, is formed chiefly by the tendinous expansion of four muscles.

There are commonly six muscles inserted in the globe of the human eye, and they are divided into four recti and two obliqui. The recti are again divided, from their situation, into superior, inferior, internal, and external; and from their functions, into a levator, depressor, adductor, and abductor. The two oblique muscles are denominated from their situation and size, one being named *obliquus superior* or *major*, the other *obliquus inferior*, or *minor*. The obliquus major is likewise called *trochlearis*, because it passes through a small cartilaginous ring, as over a trochlea or pulley.

The musculi recti are fixed by their posterior extremi-

ties at the bottom of the orbit near the foramen opticum in the elongation of the dura mater, by short narrow tendons. From thence they run wholly fleshy, toward the great circumference of the convexity of the globe, between the optic nerve and cornea lucida, where they are expanded into flat broad tendons which touch each other, and afterwards unite. These tendons are fixed first of all by a particular insertion in the circumference just mentioned, and afterwards continue their adhesion all the way to the cornea, forming the tunica albuginea.

The superior oblique muscle is fixed to the bottom of the orbit, by a narrow tendon, in the same manner as the recti, between the rectus superior and internus. From thence it runs on the orbit opposite to the interstice between these two muscles, toward the internal angular apophysis of the os frontis, where it terminates in a thin tendon, which having passed through a kind of ring as over a pulley, runs afterwards in a vagina obliquely backward under the rectus superior, that is between that muscle and the globe; and, increasing in breadth, it is inserted posteriorly and laterally in the globe, near the rectus externus.

The ring through which this muscle passes, is partly cartilaginous and partly ligamentary. The cartilaginous portion is flat, of a considerable breadth, and like half a ring. The ligamentary portion adheres strongly to the two ends of the cartilage, and is fixed in the small fossula which lies in the orbit, on the angular apophysis of the os frontis. By means of this ligament, the ring is in some measure moveable, and yields to the motions of the muscle. To the anterior edge of the ring, a ligamentary vagina is fixed, which invests the tendon all the way to its insertion in the globe.

The obliquus inferior is situated obliquely at the lower side of the orbit, under the rectus inferior, which consequently lies between this muscle and the globe. It is fixed by one extremity a little tendinous, to the root of the nasal apophysis of the os maxillare, near the edge of the orbit between the opening of the ductus nasalis, and the inferior orbital fissure.

From thence it passes obliquely, and a little transversely backward, under the rectus inferior, and is fixed in the posterior lateral part of the globe by a flat tendon, opposite to, and at a small distance from the tendon of the obliquus superior, so that these two muscles do in some measure surround the outer posterior part of the globe.

The rectus superior moves the anterior portion of the globe upward when we lift up the eyes; the rectus inferior carries this portion downward; the internus, toward the nose; and the externus, toward the temples.

When two neighbouring recti act at the same time, they carry the anterior portion of the globe obliquely toward that side which answers to the distance between these two muscles; and when all the four muscles act successively, they turn the globe of the eye round, which is what is called rolling the eyes.

The use of the oblique muscles is chiefly to counterbalance the action of the recti, and to support the globe in all the motions already mentioned. This is evident from their

their insertions, which are in a contrary direction to those of the recti, their fixed points with relation to the motions of the globe being placed forward, and those of the recti backward, at the bottom of the orbit.

The *rectus externus*, by being bent on the globe, not only hinders it from being carried outward, but also prevents the indirect motions of the *obliqui* from thrusting it out of the orbit toward the temples.

*The SUPERCILIA, and MUSCULI FRONTALES, OCCIPITALES, and SUPERCILIARES.*

The *supercilia*, or eye-brows, are the two hairy arches situated at the lower part of the forehead, between the top of the nose and temples, in the same direction with the bony arches which form the superior edges of the orbits. Their colour is different in different persons, and often in the same person different from that of the hair on the head; the hairs of which they consist are strong and pretty stiff, and they lie obliquely, their roots being turned to the nose, and their points to the temples.

The *supercilia* have motions common to them with those of the skin of the forehead, and of the hairy scalp. By these motions the eye-brows are lifted up, the skin of the forehead is wrinkled more or less regularly and transversely; and the hair and almost the whole scalp is moved, but not in the same degree in all persons. The eye-brows have likewise particular motions which contract the skin above the nose; and all these different motions are performed by the following muscles.

The frontal muscles are two thin, broad, fleshy planes of unequal lengths, lying immediately behind the skin and *membrana adiposa*, on the anterior parts of the forehead, which parts they cover from the root of the nose, and through about two thirds of the arch of the eye-brows on each side, all the way to the lateral parts of the hair on the forehead. At the root of the nose they touch each other as if they were but one muscle; and at this place their fibres are short and longitudinal, or vertical.

These muscles are fixed by the inferior extremities of their fleshy fibres immediately in the skin, running thro' the *membrana adiposa*. They cover the *musculi superciliares*, and adhere closely to them by a kind of intertexture. By the same fibres they seem to be inserted in the angular apophyses of the *os frontis*, and to be blended a little with the muscles of the *palpebræ* and nose. The upper extremities of their fleshy fibres are fixed in the external or convex surface of the *pericranium*. Each of their lateral portions covers a portion of the temporal muscle on the same side, and adheres very closely to it.

The occipital muscles are two small, thin, broad, and very short fleshy planes, situated on the lateral parts of the occiput, at some distance from each other. They are inserted by the inferior extremities of their fleshy fibres in the superior transverse line of the *os occipitis*, and also a little above it. From thence they run up obliquely from behind forward, and are fixed in the inner concave surface of the *pericranium*.

The breadth of these muscles reaches from the posterior middle part of the occiput, toward the mastoid a-

pophysis, and they diminish unequally in length as they approach the apophyses.

These four muscles seem always to act in concert, the *occipitales* being only auxiliaries or assistants to the *frontales*, the office of which is to raise the *supercilia*, by wrinkling the skin of the forehead.

The *musculi superciliares* are fleshy fasciculi, situated behind the *supercilia*, and behind the inferior portion of the *musculi frontales*, from the root of the nose to above one half of each *superciliary* arch. They are strongly inserted, partly in the *synarthrosis* of the *os nasi*, with the *os frontis*, where they come very near the proper muscles of the nose, and partly in a small neighbouring portion of the orbit. From thence they first run up a little, and afterwards more or less in the direction of the eye-brows. They are made up of several small fasciculi of oblique fibres, all fixed by one end in the manner already said, and by the other partly in the lower extremity of the muscles by which they are covered, and partly in the skin of the *supercilia*.

The action of these muscles is to depress the eye-brows, to bring them close together, and to contract the skin of the forehead immediately above the nose, into longitudinal and oblique wrinkles, and the skin which covers the root of the nose into irregular transverse wrinkles.

*The PALPEBRÆ and MEMBRANA CONJUNCTIVA.*

The *palpebræ* are a kind of veils or curtains placed transversely above and below the anterior portion of the globe of the eye; and accordingly there are two eyelids to each eye, one superior, the other inferior. The superior is the largest and most moveable in man. They both unite at each side of the globe, and the places of their union are termed *angles*, one large and internal, which is next the nose, the other small or external, which is next the temples.

The *palpebræ* are made up of common and proper parts. The common parts are the skin, epidermis, and *membrana adiposa*. The proper parts are the muscles, the *tarsi*, the *puncta* or *foramina lachrymalia*, the *membrana conjunctiva*, the *glandula lachrymalis*, and the particular ligaments which sustain the *tarsi*. The *tarsi* and their ligaments are in some measure the basis of all these parts.

The *tarsi* are thin cartilages forming the principal part of the edge of each *palpebra*; and they are broader at the middle than at the extremities. Those of the superior *palpebræ* are something less than half an inch in breadth; but in the lower *palpebræ* they are not above the sixth part of an inch; and their extremities next the temples are more slender than those next the nose.

These cartilages are suited to the borders and curvature of the eye-lids. The lower edge of the superior cartilage and upper edge of the inferior, terminate equally, and both may be termed the *ciliary edges*. The opposite edge of the upper *tarsus* is something semi-circular between its two extremities; but that of the inferior *tarsus* is more uniform, and both are thinner than the *ciliary edges*.

The

The broad ligaments of the tarsi are membranous elongations formed by the union of the periosteum of the orbits and pericranium along both edges of each orbit. The superior ligament is broader than the inferior, and fixed to the superior edge of the upper cartilage, as the inferior is to the lower edge of the lower cartilage, so that these ligaments and the tarsi, taken alone or without the other parts, represent palpebræ.

The membrana conjunctiva is a thin membrane, one portion of which lines the inner surface of the palpebræ. At the edge of the orbit it has a fold, and is continued from hence on the anterior half of the globe of the eye; adhering to the tunica albuginea; so that the palpebræ and the forepart of the globe of the eye are covered by one and the same membrane, which does not appear to be a continuation of the pericranium, but has some connection with the broad ligaments of the tarsi.

The name of *conjunctiva* is commonly given only to that part which covers the globe, the other being called simply the *internal membrane* of the palpebræ; but we may very well name the one *membrana oculi conjunctiva*, and the other *membrana palpebrarum conjunctiva*. That of the palpebræ is a very fine membrane adhering very close, and full of small capillary blood-vessels. It is perforated by numerous imperceptible pores, through which a kind of serum is continually discharged.

The conjunctiva of the eye adheres by the intervention of a cellular substance, and is consequently loose, and as it were moveable; and it may be taken hold of and separated in several places from the tendinous coat. It is of a whitish colour; and being transparent, the albuginea makes it appear perfectly white: These two coats together forming what is called the *white of the eye*.

The lachrymal gland is white, and of the number of those called *conglomerate glands*. It lies under that depression observable in the arch of the orbit near the temples, and laterally above the globe of the eye. It is a little flattened, and divided as it were into two lobes, one of which lies toward the insertion of the musculus rectus superior, the other toward the rectus externus. It adheres very closely to the fat which surrounds the muscles and posterior convexity of the eye, and it was formerly named *glandula innominata*.

From this gland several small ducts go out, which run down almost parallel to each other, through the substance of the tunica interna or conjunctiva of the superior palpebra, and afterwards pierce it inwardly near the superior edge of the tarsus.

The flat edge of each palpebra is adorned with a row of hairs called *cilia*, or the *eye-lashes*. Those belonging to the superior palpebra are bent upward, and longer than those of the lower palpebra which are bent downward. These rows are placed next the skin, and are not single, but irregularly double or triple. The hairs are longer near the middle of the palpebræ than toward the extremities, and for about a quarter of an inch from the inner angle they are quite wanting.

Along the same border of the palpebræ, near the internal membrane, or toward the eye, we see a row of small holes which may be named *seramina* or *puncta ciliaria*.

They are the orifices of the same number of small oblong glands which lie in the sulci, channels, or grooves on the inner surface of the tarsus. These little glands are of a whitish colour; and when squeezed, a sebaceous matter like soft wax, is discharged through the puncta ciliaria.

Near the great or internal angle of the palpebræ, the flat portion of their edges terminates in another which is rounder and thinner. By the union of these two edges an angle is formed.

At this place, the extremity of the flat portion is distinguished from the round portion by a small protuberance or papilla, which is obliquely perforated by a small hole in the edge of each palpebra. These two small holes are very visible, and often more so in living than in dead bodies, and they are commonly named *puncta lachrymalia*, being the orifices of two small ducts which open beyond the angle of the eye into a particular reservoir, termed *sacculus lachrymalis*, which shall be described in the article of the nose.

The puncta lachrymalia are opposite to each other, and so they meet when the eye is shut. Round the orifice of each of these points, we observe a whitish circle which seems to be a cartilaginous appendix of the tarsus, and which keeps the orifice always open.

The caruncula lachrymalis is a small reddish, granulated, oblong body, situated precisely between the internal angle of the palpebræ and globe of the eye. The substance of it seems to be wholly glandular. We discover upon it a great number of fine hairs covered by an oily, yellowish matter; and on the globe of the eye, near this glandular body, we see a semilunar fold, formed by the conjunctiva, the concave side of which is turned to the uvea, and the convex side to the nose.

#### The MUSCLES of the PALPEBRÆ.

The muscles of the palpebræ are commonly reckoned to be two, one peculiar to the upper eye-lid, named *levator palpebræ superioris*; the other common to both, called *musculus orbicularis palpebrarum*.

The levator palpebræ superioris is a very thin muscle, situated in the orbit above, and along the rectus superior oculi. It is fixed to the bottom of the orbit, by a small narrow tendon, near the foramen opticum, between the posterior insertions of the rectus superior and obliquus superior. From thence its fleshy fibres run forward on the rectus, increasing gradually in breadth, and terminate by a very broad aponeurosis in the tarsus of the superior palpebra.

By the musculus palpebrarum obliquus we understand all that extent of fleshy fibres, which by a thin stratum surrounds the edge of each orbit, and from thence, without any interruption, covers the two palpebræ all the way to the cilia. Almost all of them have a common tendon situated transversely between the internal angle of the eye and the nasal apophysis of the os maxillare. This is a slender ligamentary tendon, strongest where it is fixed in the bone, and diminishing gradually as it approaches the angle of the palpebræ, where it terminates

at the union of the points, or at the extremities of the two tarſi.

This muscle is divided into four portions, whereof the first is that which ſurrounds the orbit. The ſecond portion is that which lies between the upper edge of the orbit and the globe of the eye, and which covers the inferior edge of the orbit below, ſome of its fibres being fixed to both edges of the orbit.

The third portion ſeems to belong more particularly to the palpebræ, and the greateſt part of it is ſpent in the palpebra ſuperior. The fibres of this portion meet at the two angles of the eye, where they appear to make very acute inflections without any diſcontinuation.

The fourth portion is an appendix to the third, from which it differs chiefly in this, that its fibres do not reach to the angles, and form only ſmall arches, the extremities of which terminate in each palpebra.

All theſe different portions of the orbicular muscle adhere to the ſkin, which covers it from the upper part of the noſe to the temples, and from the ſupercilium to the upper part of the cheek. When they contract, ſeveral wrinkles are formed in the ſkin, which vary according to the different directions of the fibres.

#### *The Uſes of the Eye, and of its Appendages, in general.*

EVERY body knows that the eye is the organ of viſion. The transparent parts of the globe modify the rays of light, by different refractions; the retina and choroides receive the different impreſſions of theſe rays; and the optic nerve carries theſe impreſſions to the brain. When objects are at a great diſtance or obſcure, the pupilla is dilated; and it is contracted when objects are near, or placed in a great light. The muscles of the globe of the eye and of the palpebræ perform the motions already deſcribed.

The glandula lachrymalis continually moiſtens the forepart of the globe of the eye; and the lachrymal ſerum is equally ſpread over that globe by the motions of the ſuperior palpebra, the inner ſurface of which is in a ſmall meaſure villous. The union of the two palpebræ directs this ſerum towards the puncta lachrymalia; and the unctuous matter, diſcharged through the foramina ciliaria, hinders it from running out between the palpebræ. The large ſize and viſcid ſurface of the caruncula prevents it from running beyond the puncta, and thus forces it into them.

The ſupercilia may hinder ſweat from falling on the eyes. The ſuperior cilia, which are longer than the inferior, may have the ſame uſe; and they both ſerve to prevent duſt, inſects, &c. from entering the eyes when they are only a little open.

### SECT. VI. *The NOSE.*

THE bones of the noſe have already been deſcribed in the futures of the bones of the head,

The ſoft parts are the integuments, muscles, facculus lachrymalis, membrana piquitaria, and hairs of the nares.

The internal nares, or the two cavities of the

noſe, comprehend the whole ſpace between the external nares and poſterior openings immediately above the arch of the palate; from whence theſe cavities reach upward as far as the lamina cribroſa of the os ethmoides, where they communicate forward with the ſinus frontales, and backward with the ſinus ſphenoidales. Laterally, theſe cavities are bounded on the inſide by the ſeptum narium, and on the outſide, or that next the cheeks, by the conchæ, between which they communicate with the ſinus maxillaris.

The particular ſituation of theſe cavities deſerves our attention. The bottom of them runs directly backward, ſo that a ſtreight and pretty large ſtilet may eaſily be paſſed from the external nares, under the great apophyſis of the occipital bone. The openings of the maxillary ſinuses are nearly oppoſite to the upper edge of the oſſa malarum. The openings of the frontal ſinuses are more or leſs oppoſite to, and between the pulleys or rings of the muſculi trochleares; and by theſe marks the ſituation of all the other parts may be determined.

The inferior portion of the external noſe is compoſed of ſeveral cartilages, which are commonly five in number, and of a pretty regular figure. The reſt are only additional, ſmaller, more irregular, and the number of them more uncertain. Of the five ordinary cartilages, one is ſituated in the middle, the other four laterally. The middle cartilage is the moſt conſiderable, and ſupports the reſt, being connected immediately to the bony parts; but the other four are connected to the middle cartilage, and to each other, by means of ligaments.

The ſub-ſeptum, or portion under the ſeptum narium, is a pillar of fat applied to the inferior edge of the cartilaginous partition, in form of a ſoft moveable appendix. The thickneſs of the alæ narium, and eſpecially that of their lower edges, is not owing to the cartilages, which are very thin, but to the ſame kind of ſolid fat with which theſe cartilages are covered. The great cartilage is immoveable by reaſon of its firm connection to the bony parts of the noſe; but the lateral cartilages are moveable, becauſe of their ligamentary connections, and they are moved in different manners by the muscles belonging to them.

The external noſe is covered by the common integuments, the ſkin, epidermis, and fat. Thoſe which cover the tip of the noſe and alæ narium are a great number of glandular bodies, called *glandula ſchacæ*, the contents of which may eaſily be ſqueezed out by the fingers.

Six muscles are commonly reckoned to belong to the noſe; two recti, called alſo *pyramidales* or *triangulares*; two obliqui, or laterales; and two tranſverſi, or myrtiformes. The noſe may alſo be moved in ſome meaſure by the muscles of the lips, which in many caſes become aſſiſtants to the proper muscles of this organ.

The muſculus pyramidalis, or anterior, on each ſide, is inſerted by one extremity in the ſynarthroſis of the os frontis and oſſa naſi, where its fleſhy fibres mix with thoſe of the muſculi frontales and ſuperciliares. It is very flat, and runs down on the ſide of the noſe, increaſing gradually in breadth, and terminating by an aponeuroſis, which repreſents the baſis of a pyramid, and is in-

serted in the moveable cartilage which forms the ala of the nares.

The oblique or lateral muscle is a thin fleshy plane, lying on the side of the former. The lateral muscle is fixed by its upper extremity to the apophysis nasalis of the os maxillare, below its articulation with the os frontis, and sometimes a little lower than the middle of the inner edge of the orbit. From thence it runs toward the alar narium, and is inserted in the moveable cartilage, near the os maxillare, being covered laterally by a portion of the neighbouring muscle of the upper lip.

The transverse or inferior muscle, called also *myrtiformes*, is inserted by one end in the os maxillare, near the lower edge of the orbit, much about the place which answers to the extremity of the socket of the dens caninus on the same side. From thence it runs almost transversely upward, and is fixed in the lateral cartilages of the nose, over which it sometimes runs to the alæ of the great cartilage, to be inserted there.

The first two pairs of these muscles raise and dilate the alæ of the nares when they act; and at the same time raise the upper lip, by reason of their connection with the muscles of that part. They likewise wrinkle the skin on the sides of the nose.

The membrana pituitaria is that which lines the whole internal nares, the cellular convolutions, the conchæ, the sides of the septum narium, and, by an uninterrupted continuation, the inner surface of the sinus frontales and maxillares, and of the ductus lacrymales, palatini, and sphenoidales. It is likewise continued down from the nares to the pharynx, septum palati, &c.

It is termed *pituitaria*, because, through the greatest part of its large extent, it serves to separate from the arterial blood a mucilaginous lymph, called *pituita* by the ancients, which in the natural state is pretty liquid; but it is subject to very great changes, becoming sometimes glutinous or snotty, sometimes limpid, &c. neither is it separated in equal quantities through the whole membrane.

When we carefully examine this membrane, it appears to be of a different structure in different parts. Near the edge of the external nares it is very thin, appearing to be the skin and epidermis in a degenerated state. All the other parts of it in general are spongy, and of different thicknesses. The thickest parts are those on the septum narium, on the whole lower portion of the internal nares, and on the conchæ.

On the side next the periosteum and perichondrium it is plentifully stored with small glands, the excretory ducts of which are very long near the septum narium; and their orifices very visible.

The frontal, maxillary and sphenoidal sinuses open into the internal nares, but in different manners. The frontal sinuses open from above downward, answering to the infundibula of the os ethmoides. The sphenoidales open forwards, opposite to the posterior orifices of the nares; and the maxillares open a little higher, between the two conchæ.

The opening of the sinus maxillaris in some subjects is single, in others double; it lies exactly between the two conchæ, about the middle of their depth.

It is proper here to observe the whole extent of the maxillary sinus. Below, there is but a very thin partition between it and the dentes molares, the roots of which do, in some subjects, perforate that septum. Above, there is only a very thin transparent lamina between the orbit and the sinus. Backward, above the tuberosity of the os maxillare, the sides of the sinus are very thin, especially at the place which lies before the root of the apophysis pterygoides, through which the inferior maxillary nerve sends down a ramus to the foramen palatinum posterius, commonly called *gustatorium*. Inward, or toward the conchæ narium, the bony part of the sinus is likewise very thin.

The lachrymal sacculus is an oblong membranous bag, into which the serous fluid is discharged from the eye through the puncta lachrymalia; and from which the same fluid passes to the lower part of the internal nares. It is situated in a bony groove and canal, formed partly by the apophysis nasalis of the os maxillare and os unguis, partly by the same os maxillare and lower part of the os unguis, and partly by this lower portion of the os unguis and a small superior portion of the concha narium inferior.

This small lachrymal duct runs down for a little way obliquely backward, toward the lower and lateral part of the internal nares on each side, where its lower extremity opens on one side of the sinus maxillaris under the inferior concha. The upper part of this duct is only an half canal or groove; the lower is a complete canal, narrower than the former.

The sacculus lachrymalis may be divided into a superior or orbital portion, and an inferior or nasal portion. The orbital portion fills the whole bony groove, being situated immediately behind the middle tendon of the musculus orbicularis. The nasal portion lies in the bony canal of the nose, being narrower and shorter than the former.

The orbital portion is disposed at its upper extremity, much in the manner of an intestinum cæcum, and at the lower extremity is continued with the portio nasalis. Towards the internal angle of the eye, behind the tendon of the orbicular muscle, it is perforated by a small short canal formed by the union of the lachrymal ducts.

The nasal portion having reached the lower part of the bony duct under the inferior concha, terminates in a small, flat, membranous bag, the bottom of which is perforated by a round opening.

The substance of this sacculus is something spongy or cellularous, and pretty thick, being strongly united by its convex side to the periosteum of the bony canal.

The ductus incisorii, or naso-palatini of Steno, are two canals which go from the bottom of the internal nares cross the arch of the palate, and open behind the first or largest dentes incisorii. Their two orifices may be distinctly seen in the skeleton at the lower part of the nasal fossæ, on the anterior and lateral sides of the crista maxillares; and we may likewise perceive their oblique passage through the maxillary bones, and lastly their inferior orifices in a small cavity or fossula, called *foramen palatinum anterius*.

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The nose is the organ of smelling, by means of the villous portion of the internal membrane, to which the olfactory nerves are chiefly distributed. It is likewise of use in respiration; and the mucilaginous fluid spread over the whole pituitary membrane, prevents the air from drying that membrane, and so rendering it incapable of being affected. The nose serves likewise to regulate and modify the voice, and to this the sinuses likewise contribute. The sacculus lachrymalis receives the serum from the eyes, and discharges it upon the palate, from whence the greatest part of it runs to the pharynx.

### SECT. VII. *The EAR.*

ANATOMISTS commonly divide or distinguish the ear into external and internal. By the external ear they mean all that lies without the external orifice of the meatus auditorius in the os temporis; and by the internal ear, all that lies within the cavities of that bone, and also the parts that bear any relation thereto.

The greatest part of the external ear consists of a large cartilage very artificially framed, which is the basis of all the other parts of which this portion of the ear is made up. The internal ear consists chiefly of several bony pieces, partly formed in the substance of the ossa temporum, and especially in that portion of it called *apophysis petrosa*, and partly separated from, but contained in a particular cavity of that bone.

The external ear, taken altogether, resembles in some degree the shell of a mussel, with its broad end turned upward, the small end downward, the convex side next the head, and the concave side outward. Two portions are distinguished in the external ear taken all together; one large and solid, called in Latin *pinna*, which is the superior, and by much the greatest part; the other small and soft, called the *lobe*, which makes the lower part.

The fore-side is divided into eminences and cavities. The eminences are four in number, called *helix*, *anthelix*, *tragus*, and *antitragus*. The *helix* is the large folded border or circumference of the great portion of the ear. The *anthelix* is the large oblong eminence or rising surrounded by the *helix*. The *tragus* is the small anterior protuberance below the anterior extremity of the *helix*, which in an advanced age is covered with hairs. The *antitragus* is the posterior tubercle below the inferior extremity of the *anthelix*.

The cavities on the fore-side are four in number; the hollow of the *helix*; the depression at the superior extremity of the *anthelix*, called *fossa navicularis*; the *concha*, or great double cavity that lies under the rising termed *anthelix*, the upper bottom of which is distinguished from the lower by a continuation of the *helix* in form of a transverse *crista*; and lastly, the meatus of the external ear situated at the lower part of the bottom of the *concha*.

The back-side of the external ear shews only one considerable eminence, which is a portion of the convex side of the *concha*, the other portion being hid by the adhesion of the ear to the os temporis.

The other parts of the external ear, besides the cartilage, are ligaments, muscles, integuments, sebaceous and ceruminous glands, arteries, veins and nerves.

The cartilage of the outward ear is nearly of the same extent and figure with the large solid portion thereof, already mentioned; but it is not of the same thickness, being covered by integuments on both sides. In the lobe or soft lower portion of the ear, this cartilage is wanting.

The external ear is fixed to the cranium, not only by the cartilaginous portion of the meatus auditorius, but also by ligaments, which are two in number, one anterior, the other posterior. The anterior ligament is fixed by one extremity to the root of the *apophysis zygomatica* of the os temporis, at the anterior and a little toward the superior part of the meatus ossæ, close to the corner of the glenoid cavity; and by the other extremity, to the anterior and superior part of the cartilaginous meatus.

The posterior ligament is fixed by one end to the root of the mastoid apophysis, and by the other to the posterior part of the convexity of the *concha*, so that it is opposite to the anterior ligament.

Of the muscles of the external ear, some go between the cartilages and the os temporis, others are confined to the cartilages alone. Both kinds vary in different subjects, and are sometimes so very thin, as to look more like ligaments than muscles. The muscles of the first kind are generally three in number, one superior, one posterior, and one anterior. The superior muscle is fixed in the convexity of the *fossa navicularis*, and of the superior portion of the *concha*; from whence it runs up to the squamous portion of the os temporis, expanding in a radiated manner, and is inserted principally in the ligamentary aponeurosis, which covers the posterior portion of the temporal muscle.

The anterior muscle is small, more or less inverted, and like an appendix to the superior. It is fixed by one extremity above the root of the zygomatic apophysis, and by the other in the anterior part of the convexity of the *concha*.

The posterior muscle is almost transverse, and of a considerable breadth, being fixed by one end to the posterior part of the convexity of the *concha*, and by the other in the root of the mastoid apophysis.

The small muscles which are confined to the cartilages are only small strata of fibres found on both sides of the cartilages.

The lobe of the ear, or that soft portion which lies under the *tragus*, *antitragus*, and meatus auditorius, is made up of nothing but skin and cellular substance. The meatus auditorius is partly bony, and partly cartilaginous. The bony portion is the longest, and forms the bottom of the canal. The cartilaginous portion is the shortest, and forms the external opening or orifice of the canal.

These two portions joined endwise to each other, form a canal of about three quarters of an inch in length, of different wideness in its different parts, and a little contorted. It is lined on the inside by the skin and cellular membrane, through its whole length; and thus these integuments make up for the breaks in the cartilaginous portion.

portion, and form a kind of cutaneous tube in the other portion.

The skin which covers both sides of the cartilage contains a great number of small glands, which continually discharge an oily whitish humour, collected chiefly near the adhesions of the ear to the head, and under the fold of the helix; and these glands are of the sebaceous kind. The skin which lines the meatus auditorius contains another kind of glands, of a yellowish colour, and which may be plainly seen on the convex side of the cutaneous tube already mentioned.

These glands are disposed in such a manner as to leave reticular spaces between them, and they penetrate a little way into the substance of the skin. They are called *glandulae ceruminosae*, because they discharge that matter which is named *cerumen*, or the *wax of the ear*. The inner surface of the cutaneous tube is full of fine hairs, between which lie the orifices of the ceruminous glands. The first place in which we meet with these glands is on that part of the convex side of the cutaneous tube which supplies the breaks of the cartilaginous meatus.

All the bony parts of the organ of hearing, or bones of the internal ear, being contained in the inferior portions of the *ossa temporum*; it will be very proper to recollect what has been already said about these, in Part I.

All the bony organ of hearing may be divided into four general parts: 1. The external meatus auditorius; 2. The tympanum or barrel of the ear; 3. The labyrinth; 4. The internal meatus auditorius. It may likewise be divided into immoveable or containing parts, which take in all the four already mentioned; and moveable or contained parts, which are four little bones lodged in the tympanum, called *incus*, *malleus*, *stapes*, and *os orbiculare* or *lenticulare*.

The external auditory passage begins by the external auditory hole, the edge of which is rough and prominent; but backwards towards the mastoid apophysis it appears very much sloped. The passage itself is about half an inch in length, running obliquely from behind forward, in a curve direction, and sometimes winding a little in the middle, like a screw. Its cavity is almost oval, wider at the entry than at the middle, after which it widens again by degrees.

It terminates inwardly by an even circular edge lying in a plane very much inclined, the upper part of it being turned outward, and the lower part inward; so that the whole canal is longer on the lower side than on the upper. The concave side of the circular edge is grooved quite round.

In children this bony canal is wanting, as well as the mastoid apophysis; and the inner circular edge is a distinct ring, which in an advanced age unites intirely, and becomes one piece with the rest. It is termed the *bony circle* in infants, and indeed it is very easily separated from all the other parts.

It would seem therefore, that the whole bony canal in adults is only a prolongation of the bony circle in children; because even in a more advanced age, the whole canal may, without much difficulty, be taken out. The circular groove lies between the mastoid apophysis and the articular fissure or crack.

The tympanum or barrel of the ear is a cavity irregularly semi-spherical, the bottom of it being turned inward, and the mouth joined to the circular groove already mentioned. Both eminences and cavities are observable in it.

The remarkable eminences are three in number; a large tuberosity lying in the very bottom of the barrel, a little toward the back part; and a small irregular pyramid situated above the tuberosity, and a little more backward; the apex of it is perforated by a small hole, and on one side of the basis two small bony filaments are often found in a parallel situation. In the third eminence is a cavity shaped like the mouth of a spoon, situated at the upper and a little towards the anterior part of the bottom of the tympanum.

The principal cavities in the tympanum are, the opening of the mastoid cells or sinuosities; the opening of the Eustachian tube; the bony half-canal; the fenestra ovalis and rotunda; and to these may be added the small hole in the pyramid.

The opening in the mastoid cells is at the posterior and upper part of the edge of the barrel. The cells themselves which end there are dug in the substance of the mastoid process, being very irregular and full of windings and turnings.

The opening of the Eustachian tube is at the anterior and a little toward the upper part of the edge of the barrel. This tube runs from the tympanum, towards the posterior openings of the nasal fossae, and arch of the palate. The bony portion thereof is dug in the apophysis petrosa, along the duct of the carotid apophysis; and when it leaves that, it is lengthened out by the spinal apophysis of the *os sphenoides*.

The bony half-canal, of which the cavity resembling the mouth of a spoon is the extremity, lies immediately above the Eustachian tube, towards the upper side of the apophysis petrosa, or rather in the very substance of that upper side.

The fenestra ovalis is a hole of communication between the tympanum and labyrinth. It lies immediately above the tuberosity, the upper side of it being a little rounded, the lower a little flatted; and one extremity being turned forward, the other backward.

The fenestra rotunda is something less than the ovalis, and situated in the lower, and a little towards the posterior part of the large tuberosity; the opening of it, which is the orifice of a particular duct in the labyrinth, lying obliquely backward and outward.

The hole in the apex of the pyramid is the orifice of a cavity, which may be named the *sinus of this pyramid*.

The tympanum contains several little bones called the *bones of the ear*. They are generally four in number, denominated from something to which they are thought to bear a resemblance, *viz.* *incus*, *malleus*, *stapes*, and *os orbiculare* or *lenticulare*.

The *incus*, or anvil, resembles, in some measure, one of the anterior grinders with its roots at a great distance from each other; at least it comes nearer to this than to the shape of the anvil. It may be divided into a body and branches. The body is a large substance, the

branches



branches or legs are two, one long and one short. The body is turned forward, the short leg backward, and the long leg downward.

The body of the incus is broader than it is thick. It has two eminences, and two cavities between them, much in the same manner as we see in the crown of the first grinders.

The short leg is thick at its origin, and from thence decreasing gradually, it ends in a point. It is situated horizontally, its point being turned backward, and joined to the edge of the mastoid opening of the tympanum.

The long leg, viewed through the external auditory passage, appears to be situated vertically; but if we look upon it either on the fore or backside, we see it is inclined, the extremity of it being turned much more inward, than the root or origin. The point of the extremity is a little flattened, and bent inward like a hook, and sometimes a little hollowed like a kind of ear-picker.

The malleus or hammer is a long bone, with a large head, a small neck, an handle, and two apophyses, one in the neck, the other in the handle.

The top of the head is considerably rounded, and from thence it contracts all the way to the neck. Both head and neck are in an inclined situation, and the eminences and cavities in it answer to those in the body of the incus.

The handle is looked upon by some as one of the apophyses of the malleus; and in that case, it is the greatest of the three. It forms an angle with the neck and head, near which it is something broad and flat, and decreases gradually toward its extremity.

The apophysis of the handle, termed by others the small or short apophysis of the malleus, terminates the angle already mentioned, being extended towards the neck, and lying in a straight line with that side or border of the handle which is next it.

The apophysis of the neck, called also *apophysis gracilis*, is in a natural state very long, but so slender withal, that it is very easily broken, especially when dry; it arises from the neck, and sometimes appears much longer than it really is, by the addition of a small dried tendon sticking to it.

The stapes is a small bone, very well denominated from the resemblance it bears to a stirrup. It is divided into the head, legs, and basis.

The head is placed upon a short flattened neck, the top of it being sometimes flat, sometimes a little hollow.

The two legs taken together, form an arch, like that of a stirrup, in the concave side of which is a groove, which runs through their whole length. One leg is longer, more bent, and a little broader than the other.

The basis resembles that of a stirrup, both in its oval shape, and union with the legs, except that it is not perforated as the stirrups now are, but solid, like those of the ancients. Round its circumference, next the legs, is a little border, which makes that side of the basis appear a little hollow. The other side is pretty smooth, and one half of the circumference is something more curve than the other.

The orbicular or lenticular bone is the smallest bone in the body. It lies between the head of the stapes and ex-

trernity of the long leg of the incus, being articulated with each of these. In dry bones it is found very closely connected, sometimes to the stapes, sometimes to the incus, and might in that state be easily mistaken for an epiphysis of either of these bones.

The labyrinth is divided into three parts, the anterior, middle, and posterior. The middle portion is termed *vestibulum*; the anterior, *cochlea*; and the posterior, the *labyrinth* in particular, which comprehends the three semicircular canals.

The vestibulum is an irregularly round cavity, less than the tympanum, and situated more inward and a little more forward. These two cavities are, in a manner, set back to back, with a common partition-wall between them, perforated near the middle by the fenestra ovalis, by which the cavities communicate with one another.

The cavity of the vestibulum is likewise perforated by several other holes; on the outside, or towards the tympanum, by the fenestra rotunda; on the backside, by the five orifices of the semicircular canals; on the lower part of the fore-side, by two holes, which are the entry of the cochlea; and on the fore-side, towards the internal meatus auditorius, opposite to the fenestra ovalis, by a great many very small holes for the passage of the nerves.

The semicircular canals are three in number, one vertical and superior, one vertical and posterior, and one horizontal. The superior vertical canal is situated transversely with respect to the apophysis petrosa, the convex side or curvature of it being turned upward, and the extremities downward, one inward, the other outward. The posterior vertical canal lies parallel to the length of the apophysis, the curvature being turned backward, and the extremities forward, one upward, the other downward; and the superior extremity of this canal meets and loses itself in the internal extremity of the former. The curvature and extremities of the horizontal canal are almost on a level; the curvature lying obliquely backward, and the extremities forward, ending under those of the superior vertical canal, but a little nearer each other; and the inner being almost in the middle space, between the extremities of the posterior vertical canal.

The horizontal canal is generally the least of the three, the posterior vertical is often, and the superior vertical sometimes, the greatest; all the three canals are larger than a semicircle, forming nearly three quadrants; they are broader at the orifices than in the middle. These orifices open into the back-side of the vestibulum, being but five in number, so that in the posterior part of the vestibulum, two appear towards the inside, and three towards the outside.

The cochlea is a sort of spiral shell, with two ducts, formed in the anterior part of the apophysis petrosa, in some measure resembling the shell of a snail. The parts to be distinguished in it, are the basis, the apex, the spiral lamina, or half septum, by which its cavity is divided into two half-canals; the spindle round which the cochlea turns; and lastly, the orifices and union of the two ducts.

The basis is turned directly inward, toward the internal foramen auditorium, the apex outward, and the axis of the spindle is nearly horizontal.

The basis of the cochlea is gently hollowed, and towards the middle perforated by several small holes. The spindle is a kind of short cone, with a very large basis, which is the middle of the basis of the cochlea. Through its whole length runs a double spiral groove, which, through a microscope, shews a great number of pores.

The cochlea makes about two turns and an half from the basis to the apex; and the two ducts, being strictly united together through their whole course, form an entire common septum, which must not be confounded with the half septum or spiral lamina, as is often done. The first might be termed the common septum, the other the particular septum or half-septum.

Both of them are closely joined to the spindle, being thicker there than in any other place. The common septum is complete, and separates the turns entirely from each other; whereas the half-septum in the skeleton is only a spiral lamina, the breadth of which is terminated all round by a very thin border lying in the middle cavity of the cochlea. In the natural state, there is a membranous half-septum, which completes the partition between the two ducts.

The two half-canals turn jointly about the spindle, one being situated towards the basis of the cochlea, the other towards the apex: for which reason they have been termed the one internal, and the other external; the division of them into the upper and lower flight, not being agreeable to the natural state, but liable to convey a very false idea thereof.

The spiral or volute of the cochlea, begins at the lower part of the vestibulum, runs from thence forward to the top, then backward down to the bottom, afterwards upwards and forwards, and so on from the basis which is turned inward, to the apex which is turned outward.

The two half-canals communicate fully at the apex of the cochlea. Their separate openings are towards the basis, one of them being immediately into the lower part of the fore side of the vestibulum, the other into the fenestra rotunda.

The internal auditory hole is in the backside of the apophysis petrosa, in some measure behind the vestibulum and basis of the cochlea. It is a kind of blind hole; divided into two fossulae, one large, the other small. The large one lies lowest, and serves for the portio mollis of the auditory nerve or seventh pair. The small one is uppermost, and is the opening of a small duct through which the portio dura of the same nerve passes.

The inferior fossula is full of little holes, which, in the natural state, are filled with nervous filaments of the portio mollis, which go to the spindle, to the semicircular canals, and to those of the cochlea. It is this fossula which forms the shallow cavity at the basis of the spindle of the cochlea.

The passage for the portio dura of the auditory nerve runs behind the tympanum, and its orifice is the stylo-mastoid hole. It begins by the small fossula, and pierces from within, outwards, the upper part of the apophysis petrosa, making there an angle or curvature. From thence it is inclined backward, behind the small pyramid of the tympanum, and runs down to the stylo-mastoid hole. It communicates likewise, by a small hole, with the sinus

of the pyramid; and lower down, by another hole, with the barrel of the ear.

The internal parts of the ear are chiefly the membrana tympani, the periosteum of the barrel, ossicula auditus, labyrinth and all its cavities, the membrana mastoidea interna; the muscles of the ossicula, and the parts which complete the formation of the Eustachian tube.

The Eustachian tube is a canal or duct which goes from the tympanum to the posterior openings of the nares, or nasal fossae, and toward the arch of the palate.

The bony portion of it lies through its whole length immediately above the fissure of the glenoid or articular cavity of the os temporis, and terminates at the meeting of the spiral apophysis of the os sphenoidale with the apophysis petrosa of the os temporis.

The other or mixed portion reaches in the same direction from this place to the internal ala of the apophysis pterygoideae, or to the posterior and outer edge of the nares. It is properly divided into four parts, two superior, and two inferior.

The two upper parts or quarters are bony; and of these the innermost is formed by the side of the apophysis petrosa; the outermost by the side of the apophysis spinalis of the os sphenoidale, so that the upper half of this portion of the tube is bony. Of the two inferior parts, the internal is cartilaginous, and the external membranous; so that the lower half of this portion of the tube is partly cartilaginous next the os sphenoidale, and partly membranous next the apophysis petrosa.

The Eustachian tube thus formed, is very narrow in the bony part next the ear. The other portion grows gradually wider, especially near the posterior nares, where the inner cartilaginous side terminates by a prominent edge, and the outer side joins that of the neighbouring nostril. The cavity of the tube is lined by a membrane like that of the internal nares, of which it appears to be a continuation.

The situation of the two tubes is oblique, their posterior extremities at the ears being at a greater distance than the anterior at the nares, and the convex sides of the prominent edges are turned toward each other. The openings of the tubes are oval at this place, as is likewise their whole cavity, especially that of the mixed portion.

The membrana tympani is a thin, transparent, flatish pellicle, the edge of which is round, and strongly fixed in the orbicular groove which divides the bony meatus of the external ear from the tympanum or barrel. This membrane is very much stretched or very tense, and yet not perfectly flat: for on the side next the meatus externus it has a small hollowess, which is pointed in the middle; and on the side next the tympanum it is gently convex, and also pointed in the middle.

This membrane is situated obliquely, the upper part of its circumference being turned outward, and the lower part inward, suitably to the direction of the bony groove already mentioned. It is made up of several very fine laminae, closely united together. The external lamina is in some measure a production of the skin and cuticula of the external meatus; the internal lamina is a continuation of the periosteum of the tympanum; and when the membrane has been first macerated in water,

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each of these laminae may be subdivided into several others.

The depression in the middle of the membrana tympani is caused by the adhesion of the little bone called *malleus*, the handle of which is closely joined to the inside of the membrane from the upper part of the circumference all the way to the center to which the end of the handle is fixed. This handle seems to lie in a very fine membranous duplicature, by means of which it is tied to the membrana tympani, and which serves it for a periosteum.

The periosteum of the tympanum or barrel of the ear produces that of the small bones; it is likewise continued over the two fenestræ, and enters the eustachian tube, where it is lost in the inner membrane of that duct.

The cellulae mastoideæ are very irregular cavities in the substance of the mastoid apophysis, which communicate with each other, and have a common opening towards the inside, and a little above the posterior edge of the orbicular groove. These cells are lined by a fine membrane, which is partly a continuation of the periosteum of the tympanum, and partly seems to be of a glandular structure like a kind of the membrana pituitaria. The mastoid opening is opposite to the small opening of the Eustachian tube, but a little higher.

The ligaments of the ossicula come next in order. The incus is tied by a strong short ligament, fixed in the point of the short leg, to the edge of the mastoid opening. Between the incus and malleus we find a small, thin cartilage. The malleus is connected through the whole length of its handle to the inside of the membrana tympani.

The malleus has three muscles, one external, one anterior, and one internal; and the stapes has one muscle. The external or superior muscle of the malleus, is a thin fasciculus of fleshy fibres lying along the upper part of the bony meatus auditorius, between the periosteum and the other integuments. The outer part of it is pretty broad, and it contracts by degrees as it advances towards the upper part or break of the orbicular groove of the tympanum, into which it enters by a small tendon, above the membrana tympani, and is inserted in the neck of the malleus, near the small eminence or short apophysis of the handle.

The anterior muscle of the malleus, is fleshy, long, and thin. It runs along the outside of the Eustachian tube, to which it adheres very closely through its whole length. Its anterior extremity is fixed in that side of the tube just before the sphenoidal spine; and the posterior extremity ends in a long thin tendon, which runs in the articular or glenoid fissure of the os temporis, through a small oblique notch; in which fissure it enters the tympanum, and is inserted in the long thin apophysis of the malleus. It is partly accompanied by a nerve, which forms what is called the *chorda tympani*.

The internal muscle of the malleus is very fleshy and distinct. It lies along the inside of the Eustachian tube, partly on the cartilaginous, and partly on the bony portion, being fixed by one extremity in the apophysis petrosa. Afterwards it runs along the cavity of the bony half-canal of the tympanum, within which cavity it is invested by a portion of a membranous or ligamentary va-

gina, which being fixed to the edges of the half-canal, forms an intire tube therewith.

At the extremity of this bony half-canal, where we observe the cavity shaped like the mouth of a spoon, this muscle ends in a tendon, which is bent round the transverse bony or ligamentary ridge in the last-named cavity, as over a pulley, and is inserted in the neck of the malleus above the small apophysis, advancing likewise as far as the handle.

The muscle of the stapes is short and thick, and lies concealed within the small bony pyramid at the bottom of the tympanum. The cavity which it fills, touches very nearly the bony canal of the portio dura of the auditory nerve; and it terminates in a small tendon which goes out of the cavity through the small hole in the apex of the pyramid. As it goes through the hole it turns forward, and is inserted in the neck of the stapes on the side of the longest and most crooked leg of that bone.

The three parts of the labyrinth, that is, the vestibulum, semicircular canals, and cochlea, are lined by a fine periosteum, which is continued over all the sides of their cavities, and shuts the two fenestræ of the tympanum.

The periosteum of the two sides of the bony spiral lamina advances beyond the edge of that lamina, and forms a membranous duplicature, which extending to the opposite side compleats the spiral septum.

This septum separates the two half-canals from the basis to the apex; but there it leaves a small opening, by which the small extremities of the half-canals communicate with each other. The large extremity of the external half-canal ends by an oblique turn in the fenestra rotunda, which is shut by a continuation of the periosteum of that canal. The large extremity of the other half-canal opens into the vestibulum; and these two extremities are intirely separated by a continuation of the periosteum.

The ear is the organ of which we can most distinctly unfold the structure, and demonstrate the greatest number of parts, that is, of small machines of which it is made up. We know likewise in general, that it is the organ of hearing; but when we endeavour to discover the uses of each of these parts, that is, how each contributes to the great design of the whole, after having thoroughly examined them, we must be obliged to own, that the greatest part of what the most able philosphers have said upon this subject, is without any real foundation.

## SECT. VIII. The MOUTH.

THE mouth may be distinguished into external and internal, and the parts of which it consists may likewise come under the same two general heads.

The parts of the neck still undescribed are only the larynx, pharynx, glandulae thyroideæ, and the musculus cutaneus, which really belong to the head; and therefore, instead of making a particular section for so small a number of parts, especially since the larynx and pharynx have so near a relation to the internal parts of the mouth, we are under a necessity of describing them, before proceeding to the mouth in particular.

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## THE LARYNX.

THE larynx forms the protuberance in the upper and anterior part of the neck, called commonly *promontorium Adami*.

It is chiefly made up of five cartilages, *viz.* Cartilago thyroïdes, which is the anterior and largest; cricoides, the inferior, and basis of the rest; two arytenoides, the posterior and smallest; and the epiglottis, which is above all the rest. These cartilages are connected together by ligaments, and they have likewise muscles, glands, membranes, &c. belonging to them.

The cartilago thyroïdes is large and broad, and folded in such a manner as to have a longitudinal convexity on the fore-side, and two lateral portions, which may be termed *ala*. The upper part of its anterior middle portion is formed into an angular notch; the upper edge of each *ala* makes an arch; and, together with the middle notch, these two edges resemble the upper part of an ace of hearts.

The lower edge of each *ala* is more even, and the posterior edges of both are very smooth, being lengthened out both above and below by apophyses, which are named the *cornua* of the thyroid cartilage.

The cricoid cartilage resembles a thick, irregular ring, very broad on one side, and narrow on the other; or it may be compared to a small portion of a thick tube, cut horizontally at one end, and very obliquely at the other. It is distinguished into a basis and top, into an anterior, posterior, and two lateral sides. The basis is almost horizontal, when we stand; and to this the *arteria aspera* is connected; so that the cricoides may be looked upon as the upper extremity of the trachea.

The posterior portion of the cricoides is larger than the rest, and its posterior or convex side is divided by a longitudinal eminence or prominent line into distinct surfaces, for the insertion of muscles. The top is gently sloped above this prominent line, and terminates on each side by a kind of obtuse angle, formed between it and the oblique edge of each lateral portion of this cartilage.

The whole posterior side is distinguished into two lateral portions by two prominent lines, each of which runs down almost in a straight direction from the articular surface at the top, a little below the middle of this side, where it terminates in another articular line a little concave; and near these four articular surfaces there are small tubercles. The two superior surfaces are for the articulation of the cartilagine *arytenoides*; and the two inferior, for the articulation of the inferior *cornua* or appendices of the cartilago thyroïdes.

The cartilagine *arytenoides* are two small, equal, similar cartilages, which, joined together, resemble the spout of an ewer, and they are situated on the top of the cricoides. In each, we may consider the basis; *cornua*; two sides, one posterior and concave, the other anterior and convex; and two edges, one internal, the other external, which is very oblique. The bases are broad and thick, and have each a concave articular surface, by which they are joined to the cricoides.

The *cornua* are bent backward, and a little toward each other.

The epiglottis is an elastic cartilage, nearly of the figure of a purslain leaf, narrow and thick at the lower part, thin and slightly rounded at the upper part, gently convex on the fore-side, and concave on the back-side. It is situated above the anterior or convex portion of the cartilago thyroïdes; and its lower extremity is tied by a short, pretty broad, and very strong ligament, to the middle notch in the upper edge of that cartilage. It is perforated by a great number of holes, something like those in the leaves of the hypericum, or St John's Wort, which are hid by the membranes that cover its two sides.

The cartilago thyroïdes is connected to the cricoides by several short strong ligaments, round the articulations of the two inferior *cornua*, with the lateral articular surfaces of the cricoides. The apices of the superior *cornua* are fixed to the posterior extremities of the great *cornua* of the *os hyoides*, by slender, round ligaments, about a quarter of an inch in length.

The thyroïdes is likewise connected to the *os hyoides* by a short, broad, strong ligament, one end of which is inserted in the superior notch of the cartilage, and the other in the lower edge of the basis of the bone. It has also two ligaments at the middle of the concave side, which belong to the *arytenoides*.

The cricoides is tied to the lower part of the thyroïdes by a strong ligament; and by the ligaments already mentioned, to the inferior *cornua* of that cartilage. Its basis is fixed to the first cartilaginous ring of the trachea *arteria*, by a ligament exactly like those by which the other rings are connected together; and the membranous or posterior portion of the trachea is likewise fixed to the posterior part of the basis of the cricoides.

The cartilagine *arytenoides* are connected to the cricoides by ligaments, which surround their articulations with the top of that cartilage. Anteriorly the basis of each *arytenoides* is fixed to one end of a ligamentary cord, which by its other end is inserted about the middle of the concave side of the anterior portion of the thyroïdes. At their insertions in the thyroïdes, these two ligaments touch each other, but a small space is left between them, where they are fixed in the two *arytenoides*, and they seem likewise to have a small adhesion to the top of the cricoides. This is what is called the *glottis*.

Under these two ligamentary cords there are two others, which run likewise from behind forward. The interstice between the superior and inferior cords on each side form a transverse fissure, which is the opening of a small membranous bag, the bottom of which is turned outward, that is, toward the *ala* of the thyroïdes. These two sacculi are chiefly formed by a continuation of the internal membrane of the larynx, and the inner surface of their bottom appears sometimes to be glandulous.

On the anterior surface of the arytenoid cartilages, there is a small depression between the basis and the convex upper part. This depression is filled by a glandulous body, which not only covers the anterior surface of each *arytenoides*, but is likewise extended forward from the basis over the posterior extremity of the neighbouring ligamentary cord.

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The epiglottis has likewise two lateral ligaments, by which it is connected to the arytenoides, all the way to their points or cornua. It has also a membranous ligament, which running along the middle of its anterior or concave side, ties it to the root or basis of the tongue. This ligament is only a duplicature of the membrane which covers the epiglottis, continued to the neighbouring parts. Lastly, there are two lateral membranous ligaments belonging to it, fixed near the glandulous bodies called *amygdala*.

The epiglottis is not only perforated by the regular holes already mentioned, but has likewise a great number of small irregular fissures and breaks, which are so many different lacunæ situated between its two membranes, and filled with small glands, the excretory orifices of which are chiefly on the backside of this cartilage.

The larynx gives insertion to a number of muscles, which shall now be described.

The sterno-thyroidæi are two long, flat, narrow, thin muscles, like ribbons, broader above than below, and situated along that part of the neck which lies between the thyroid cartilage and the sternum. They are covered by the sterno-hyoidæi, and they cover the thyroid glands, passing immediately before them.

Each muscle is fixed, by its lower extremity, partly in the superior portion of the inner or backside of the sternum, partly in the ligament and neighbouring portion of the clavicle, and partly in the cartilaginous portion of the first rib. Sometimes it runs a great way down on the first bone of the sternum, and crosses the muscle on the other side. From thence it runs up on the *aspera arteria*, close by its fellow, passes before the thyroid glands, over the cricoid cartilage; and is inserted, by its upper extremity, in the lower part of the lateral side of the thyroid cartilage, and partly along that whole side.

The thyro-hyoidæi, or hyo-thyroidæi are two flat, thin muscles, lying close by each other, between and above the former. Each of them is inserted, by its upper extremity, partly in the basis, and partly in the neighbouring part of the great cornua of the *os hyoides*; and by its lower extremity, in the lower part of the lateral side of the thyroid cartilage, immediately above the superior extremity of the sterno-thyroidæus; and both this superior extremity of the last named muscle, and the lower extremity of the thyro-hyoidæus, are, at their place of union, confounded a little with the thyro-pharyngæus inferior.

The crico-thyroidæi are two small muscles, situated obliquely at the lower part of the thyroid cartilage. They are inserted by their lower extremities in the anterior portion of the cricoid cartilage, near each other, and by their superior extremities, laterally in the lower edge of the thyroid cartilage, at a distance from each other.

The two muscoli crico-arytenoidæi posteriores are situated posteriorly at the large or back portion of the cricoides, filling almost the two longitudinal surfaces of that portion, and distinguished by the prominent line between these two surfaces. Each of them runs up obliquely, and is inserted, by its upper extremity, in the posterior part of the basis of the arytenoid cartilage of the same side, near the angle of that basis.

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The two crico-arytenoidæi laterales are small, and situated more laterally than the former. Each muscle is fixed by one end to the side of the broad part of the cricoides, and by the other, to the lower part of the side of the neighbouring arytenoides.

The two thyro-arytenoidæi are very broad, each muscle being situated laterally between the thyroides and cricoides. It is fixed by a broad insertion in the inside of the ala of the thyroid cartilage; and the fibres contracting from thence, run from before backward, and from below upward, towards the neighbouring arytenoid cartilage, in which they are inserted, from the glottis to the angle of the basis.

The arytenoidæi are small muscles lying on the posterior concave sides of the arytenoid cartilages, of which two are called *crucial arytenoidæi*, and one *transverse*.

The crucial muscles run each obliquely from the basis of one arytenoid cartilage, to the middle and upper part of the other, the left muscle covering the right.

The arytenoidæus transversalis is inserted more or less directly, by both extremities, in the two arytenoid cartilages.

The two thyro-epiglottici cross the thyro-arytenoidæi, being inserted in the inner lateral part of the thyroides, and laterally in the epiglottis.

The aryteno-epiglottici are small fleshy fasciculi, each of which is fixed by one extremity in the head of one of the arytenoid cartilages, and by the other in the nearest edge of the epiglottis.

The larynx serves particularly to admit and let out the matter of respiration; and the solidity of the pieces of which it is composed hinders not only external objects, but also any hard thing which we swallow, from disordering this passage. The glottis, being a narrow slit, modifies the air which we breathe; and as it is very easily dilated and contracted, it forms the different tones of the voice, chiefly by means of the different muscles inserted in the cartilages arytenoidææ, to which the other muscles of the larynx are assistants.

The whole larynx is likewise of use in deglutition, by means of its connection with the *os hyoides*, to which the digastric muscles of the lower jaw adhere; which muscles raise the larynx together with the *os hyoides* every time we swallow.

The facility of varying and changing the tone of the voice, depends on the flexibility of the cartilages of the larynx, and decreases in proportion as we advance in age, because these cartilages gradually harden and ossify.

The muscoli sterno-thyroidæi serve in general to pull down the thyroid cartilage, and the whole larynx along with it. The thyro-hyoidæi may, as occasion requires, either draw up the larynx toward the *os hyoides*, or draw that bone downward toward the cartilago thyroides.

It is difficult to determine the use of the crico-thyroidæi from their situation. They may either pull the cricoides obliquely backward, or the thyroides obliquely forward.

Both the lateral and posterior crico-arytenoidæi, may separate the arytenoid cartilages, and thereby open or dilate the glottis.

The thyro-arytenoidæi acting together, draw both the

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arytenoid cartilages forward, and consequently loosen the glottis, and render it capable of the smallest quaverings of the voice.

The arytenoidæ bring the arytenoid cartilages close together, and press them against each other; and when the cartilages are in this situation, they may at the same time be inclined either forward by the thyro-arytenoidæ, or backward by the crico-arytenoidæ posteriores. By this means the glottis, when shut, may be either relaxed or tense; and in this last case it is intirely shut, as when we hold in our breath in straining.

The general use of the epiglottis is to cover the glottis like a pent-house, and thereby hinder any thing from falling into it when we eat or drink; it serves likewise to hinder the air which we inspire from rushing directly upon the glottis, but by splitting it, as it were, obliges it to enter by the sides, or in an oblique course. The muscles of the epiglottis do not appear to be absolutely necessary for that cartilage; for in deglutition, it may be sufficiently depressed by the basis of the tongue; and it may raise itself again by its own elasticity. The thyro-epiglottici and aryteno-epiglottici may serve to shut any lateral openings that might remain when the epiglottis is depressed by the basis of the tongue; and the hyo-epiglottici may pull it a little forward in strong respirations, as in sighing, yawning, &c.

#### THE PHARYNX.

The pharynx is a muscular and glandular bag, the outer surface of which is closely joined to the inner surface of all that space which is at the bottom of the mouth, behind the posterior nares, uvula, and larynx, and which reaches from the great or anterior apophysis of the os occipitis all the way to the œsophagus, which is the continuation of the pharynx.

Though almost all the muscular or fleshy portions of which the pharynx is composed, concur in the formation of one continued bag or receptacle, they are nevertheless very distinguishable from each other, not only by their different insertions, from which they have been denominated, but also by the different directions of their fibres. The greatest part of them may be looked upon as digastric muscles, the middle tendons of which lie backward in one longitudinal line, which in some subjects appears plainly like a linea alba.

The cephalo-pharyngæi are inserted in the lower side of the apophysis basilaris, or great apophysis of the os occipitis, about the middle of the posterior part. From thence they separate laterally, and sometimes join the stylo-pharyngæi. The linea alba of the pharynx begins by the middle adhesion of these muscles.

The petro-pharyngæi are inserted in the lower part of the extremity of the apophysis petrosa; the spheno-pharyngæi, partly in the os sphenoides, directly above the internal ala of the apophysis pterygoides, and partly in the neighbouring cartilaginous portion of the Eustachian tube; and the pterygo-pharyngæi, in the edge of the same ala of the apophysis pterygoides. These three muscles on each side run obliquely backward, covering each

other by some fibres, and meet at the linea alba. Their use may be to draw the middle portion or great cavity of the pharynx upward.

The stylo-pharyngæi are inserted anteriorly by one extremity in the apophysis, or epiphysis styloides. From thence each muscle runs down obliquely along the lateral part of the pharynx, covering and crossing the other muscles. It extends gradually in breadth as it descends, and forms two principal portions, one superior which is narrow, and one inferior which is broad. The narrow portion is spread among the muscular fibres above the thyroid cartilage, and the broad portion is inserted in the side of that cartilage; add thus the stylo-pharyngæus is partly a true stylo-thyroidæus. These muscles may draw the pharynx laterally upward, especially by their thyroid portions.

The perystaphylo-pharyngæi are two small muscles inserted between the uvula and lower extremity of the internal ala of the apophysis pterygoides, and run obliquely backward on the sides of the pharynx. The glosso-pharyngæi are fibres which run along the lateral edges of the tongue, from which they are parted backward, and run down on the sides of the pharynx under the stylo-pharyngæi.

The hyo-pharyngæi in general are those on each side which are inserted in the os hyoides; and they may be reckoned three pairs, the basio-pharyngæi, kerato-pharyngæi minores, and kerato-pharyngæi majores; these denominations being taken from their insertions in the basis, and in the small and great cornua of the os hyoides.

The mylo-pharyngæi is a muscular portion distinct from the genio-glossus, inserted in the side of the pharynx.

The syndesmo-pharyngæi are fasciculi of muscular fibres very distinctly inserted by one end along the ligaments by which the superior cornua of the cartilago thyroides are connected to the extremities of the great cornua of the os hyoides. From thence they run backward and meet at the linea alba.

The thyro-pharyngæi are very broad, and each muscle is inserted along the outside of the ala of the cartilago thyroides, between the edge of that cartilage and the oblique line in which the thyro-hyoidæi are fixed. From thence they run up obliquely backward, and meet under the linea alba.

The crico-pharyngæi are inserted each in the lower part of the side of the cricoid cartilage. They seem to be appendices of the thyro-pharyngæi, shewing no other marks of distinction but these insertions, and a small difference in direction, because as they run backward they descend a little.

The lowest of these muscular fibres make a complete circle backward, between the two sides of the basis of the cartilago cricoides. This circle is the beginning of the œsophagus, and has been thought by some to form a distinct muscle, called *œsophagus*.

The particular uses of all these muscles are very difficult to be determined. It is certain that those of the middle and lower portions of the pharynx serve chiefly for deglutition.

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## THE PALATE, UVULA, &amp;c.

The palate is that arch or cavity of the mouth, situated anteriorly by the alveolar edge and teeth of the upper jaw, and reaching from thence to the great opening of the pharynx. This arch is partly solid and immovable, and partly soft and moveable. The solid portion is that which is bounded by the teeth, being formed by the two ossa maxillaria, and two ossa palati. The soft portion lies behind the other, and runs backward like a veil fixed to the edge of the ossa palati, being formed partly by the common membrane of the whole arch, and partly by several muscular fasciculi, &c.

The membrane that covers all this cavity is like that which lines the superior and middle portions of the pharynx. It is very thick set with small glands, the orifices of which are not so sensible as in the pharynx, and especially in the verge of the superior portion thereof.

This membrane, together with that of the posterior nares, forms, by an uninterrupted continuation, the anterior and posterior surface of the soft portion, or septum palati; so that the muscular fasciculi of this portion lie on the duplicature of a glandulous membrane.

The septum, which may likewise be termed *velum*, or *uvula palati*, terminates below by a loose floating edge, representing an arch situated transversely above the basis or root of the tongue. The highest portion or top of this arch sustains a small, soft, and irregularly conical glandulous body, fixed by its basis to the arch, and its apex hanging down without adhering to any thing, which is called *uvula*.

On each side of the uvula there are two muscular half arches, called *columnae septi palati*. They are all joined to the uvula by their upper extremities, and disposed in such a manner, as that the lower extremities of the two which lie on the same side are at a little distance from each other, and so as that one half-arch is anterior, the other posterior, an oblong triangular space being left between them, the apex of which is turned toward the basis of the uvula.

The two half arches on one side, by joining the like half arches on the other side, form the entire arch of the edge of the septum. The posterior half arches run, by their upper extremities, more directly toward the uvula than the anterior. The anterior half arches have a continuation with the sides of the basis of the tongue, and the posterior with the sides of the pharynx. At the lower part of the space left between the lateral half arches on the same side, two glands are situated, termed *amygdalae*.

The half arches are chiefly made up of several flat fleshy portions, almost in the same manner with the body of the septum. The membrane which covers them is thinner than the other parts of it towards the palate, pharynx, and tongue. Each portion is a distinct muscle, the greatest part of which terminate by one extremity in the substance of the septum and of the half arches, and by the other extremity in parts different from these.

As anatomists used formerly to ascribe all these muscles, as far as they knew them, to the uvula, without

any regard to the septum, they termed them in general either *pteryo-staphylini*, or *peri-staphylini*.

The glosso-staphylini are two small muscles, fixed each in the lower and lateral part of the basis of the tongue; from whence they run up obliquely backward along the anterior half arches of the septum palati, and terminate insensibly on each side near the uvula, some of their fibres being spread through the septum.

The pharyngo-staphylini are likewise two small muscles, each of them being fixed by one extremity to the lateral part of the muscoli thyro-pharyngei, as if they were portions detached from these muscles. From thence they run up obliquely forward along the two posterior half arches of the septum, and terminate in the septum above the uvula, where they meet together, and seem to form an entire arch by the union of their fibres.

The thyro-staphylini are two small muscles, which accompany the pharyngo-staphylini very closely, through their whole course, except that their posterior extremities are fixed in the thyroid cartilages near the other muscles. They are inserted in the septum in the same manner with the former.

The sphenosalpingo-staphylini are each fixed by one extremity, partly to the sphenoidal side of the bony portion of the Eustachian tube, partly to the nearest soft portion of the same tube. From thence it runs toward the external ala of the apophysis pterygoides, into which one portion of this muscle is inserted. The other portion runs to the end of the ala, and turns round to the forked extremity thereof, as over a pulley, and is afterwards inserted in the septum palati, near the uvula.

The pterygo-staphylinus superior is so named because it has a small insertion in the upper part of the apophysis pterygoides, besides that in the sphenoidal part of the bony portion of the tube. The pterygo-staphylinus inferior on each side, is a small muscle, inserted by one extremity in the uncus pterygoidens, and by the other in the septum near the uvula.

The petrosalpingo-staphylini, or salpingo-staphylini interni, are those which are commonly called *peri-staphylini interni*. Each muscle is fixed by one extremity, partly to the inner side of the bony portion of the Eustachian tube, or that next the apophysis petrosa, partly along the cartilaginous portion of the same tube. From thence it passes a little way under the soft membranous part, and then, turning toward the septum, is fixed in the edge, and partly in the upper side thereof.

The staphylini, or epistaphylini, are two small fleshy ropes, closely united together, as if they made but one muscle. They are fixed by one extremity in the common point of the posterior edges of the ossa palati, and from thence run downward and backward along the middle of the septum, and likewise along the middle of almost the whole uvula. These muscles have been termed *azygos Morgagnii*, from the discoverer, but he considered them as one muscle. The pterygo-staphylini inferiores are of the same kind, and might be termed *staphylini*, or *epistaphylini laterales*, and these last, *medii*.

The septum palati serves to conduct the lachrymal lymph, and that which is continually collected on the arch of the palate, into the pharynx. It serves for a valve.

valve to hinder what we swallow, and especially what we drink, from returning by the nares. The uses of the different muscles of the septum are not as yet sufficiently known, nor the different motions of which it is capable.

### THE TONGUE.

THE tongue is divided into the basis and point; the upper and under sides; and the lateral portions or edges. The basis is the posterior and thickest part; the point, the anterior and thinnest part. The upper side is not quite flat, but a little convex, and divided into two lateral halves, by a shallow depressed line, called *linea lingue mediana*. The edges are thinner than the other parts, and a little rounded as well as the point. The lower side reaches only from the middle of the length of the tongue to the point.

The tongue is principally composed of very soft fleshy fibres, intermixed with a particular medullary substance, and disposed in various manners. Many of these fibres are confined to the tongue without going any farther, the rest form separate muscles which go out from it in different ways, and are inserted in other parts. All the upper side of the tongue is covered by a thick membrane of a papillary texture, upon which lies another very fine membrane like a kind of epidermis, which is likewise continued over the lower side, but without papillæ.

Three sorts of papillæ may be distinguished in the upper side of the tongue, capitata, semi-lenticular, and villosa. Those of the first kind are the largest, resembling little mushrooms with short stems, or buttons without a neck. They lie on the basis of the tongue in small superficial fossulae.

They resemble small conglomerate glands seated on a very narrow basis, and each of them has sometimes a small depression in the middle of their upper or convex side. They occupy the whole surface of the basis of the tongue. They are glandular papillæ, or small salival or mucilaginous glands.

We oftentimes observe, about the middle of this part of the tongue, a particular hole of different depths, the inner surface of which is entirely glandular, and filled with small papillæ, like those of the first kind. It is called *foramen cæcum Morgagnii*, as being first described by that author. Since that time M. Vaterus has discovered a kind of salival ducts belonging to it; and M. Heister found two of these ducts very distinctly, the orifices of which were in the bottom of the foramen cæcum near each other. He observed the ducts to run backward, divaricating a little from each other, and that one of them terminated in a small oblong vesicle situated on the side of the small cornu of the os hyoides.

The papillæ of the second kind, or semi-lenticular, are small orbicular eminences, only a little convex, their circular edge not being separate from the surface of the tongue. When we examine them in a sound tongue, with a good microscope, we find their convex sides full of small holes or pores, like the end of a thimble.

They lie chiefly in the middle and anterior portions of the tongue, and are sometimes most visible on the edges,

where they appear to be very smooth and polished, even to the naked eye.

The papillæ of the third kind, or villosa, are the smallest and most numerous: They fill the whole surface of the upper side of the tongue, and even the interstices between the other papillæ.

The fleshy fibres of which the tongue is composed, and which go no further than the tongue, may be termed *musculi lingue interiores*; and they are the same which Spigelius named *musculi linguales*. The fibres of these muscles consist of three general kinds; longitudinal, transverse, and vertical; and each of these situations admits of different degrees of obliquity. The longitudinal fibres point to the basis and apex of the tongue, and seem partly to be expansions of the musculi stylo-glossi, hyo-glossi, and genio-glossi; of which hereafter. The vertical fibres seem likewise to be in part produced by the same genio-glossi, and the transverse by the mylo-glossi.

The musculi exteriores are four in number, and make a part of the body of the tongue.

The mylo-glossi are small fleshy planes, situated transversely, one on each side, between the ramus of the lower jaw, and the basis of the tongue. Their insertion in the jaw is immediately above the posterior half of the mylo-hyoidæus, between the prominent oblique line on the inside of the bone, and the dentes molares. From thence they run toward the basis of the tongue, and are lost there on one side of the glosso-pharyngæi.

The stylo-glossi are two long small muscles which run down from the styloid apophyses, or epiphyses, and form two portions of the lateral parts of the tongue. Each muscle is fixed in the outside of the apophysis styloides by a long tendon. The stylo-hyoidæus is the lowest, and the stylo-pharyngæus is in the middle, but more backward.

As it runs down almost opposite to the inside of the angle of the lower jaw, it sends off a pretty broad and short lateral aponeurotic ligament, which being fixed in that angle serves for a frænum, or ligamentum suspensorium, to the muscle in this part of its course. From thence it passes on to the side of the basis of the tongue, where it first of all adheres closely to the lateral portion of the hyo-glossus, and then forms, together with that muscle, a large portion of the side of the tongue.

The hyo-glossi are each inserted in three parts of the os hyoides that lie near each other, in the basis, in the root of the great cornu, and in the symphysis between these two; and on this account the hyo-glossus has been divided by some into two or three distinct muscles, called *basio-glossus*, *cerato-glossus*, and *chondro-glossus*.

It is situated on the inside, and a little lower than the stylo-glossus, with which it forms the lateral part of the tongue. The portion inserted in the basis of the os hyoides lies more anteriorly, and is larger than the other two; that which is inserted in the symphysis is the least, and that inserted in the great cornu the most posterior. This muscle is partly sustained by the mylo-hyoidæus, as by a girth; and the anterior portion is distinguished from the rest by the passage of the nerves of the fifth pair, and of the arteries which accompany them.

The genio-glossi are situated close to each other on the lower



lower side of the tongue. Each muscle is inserted in the inner or backside of the symphysis of the lower jaw, immediately above the genio-hyoidetus. From thence it runs backward toward the os hyoides, to which the lowest fibres are connected by a ligamentary membrane; and in this course its fibres are spread through the substance of the tongue in a very singular manner.

Of these fibres, some run directly towards the os hyoides, all the way to the basis of the tongue; some are inflected forward, and go to the point of the tongue; and the rest are distributed in a radiated manner, forward, upward, and backward in the substance of the tongue; and the middle fibres expand laterally toward the edges of the tongue.

The two genio-glossi run close to each other, as if they formed but one mass; but they are evidently divided by a very thin cellular membrane, or middle septum, which penetrates a good way between the two lateral, or right and left halves of the tongue, lying in the same plane with the linea mediana of the upper side of the tongue.

These two muscles, by their posterior straight fibres which go to the basis, can draw the tongue out of the mouth, and bring it back again by their anterior bent fibres which go to the point. They can either successively, or all at once, make the tongue longitudinally hollow or like a groove; and they can at the same time contract it, by the lateral expansion of their middle fibres.

When either of the stylo-glossi acts, it turns the tongue toward the cheek, and forces the aliment between the upper and lower molars. When they act jointly with the lateral portions of the superior fleshy plane of the tongue, they turn the tongue obliquely upward to the teeth of the upper jaw, and near the cheeks, as when we bring down any part of the food that may have stuck there after mastication. When they act jointly with the lateral portions of the hyo-glossi, they turn the tongue downward between the lower teeth and the cheek.

When all the parts of the hyo-glossi act together, they shorten the tongue. They likewise turn the point of the tongue between the teeth and the under lip, and make it pass over that lip. The superior fleshy plane of the body of the tongue bends it upward toward the palate, and makes it pass along or lick the upper lip. The myo-glossi serve as a frænum to one side of the basis, while the point is turned to the other side. The ligamenta suspensoria of the stylo-glossi may answer the same purpose, and even supply the want of the myo-glossi.

The tongue is fixed in the mouth, not only by muscles, but also by ligaments, which are for the most part membranous. The principal ligament is that called the *frænum*, which is the prominent fold that appears first under the tongue, when we raise it, with the mouth opened, and is no more than a continuation or loose duplication of that membrane which covers the inferior cavity of the mouth. It covers the curvature of the anterior portion of the genio-glossi from the point of the tongue, almost as high as the middle interstice between the lower dentes incisarii.

The other ligaments of the tongue are the small membranous fold which runs along the middle of the convex side of the epiglottis, to the basis of the tongue; and

the membranous folds which cover the inferior half arches of the septum palati. These three folds are continuations of the membrane which covers the neighbouring parts. The aponeurotic ligaments of the stylo-glossus may be looked upon as true lateral ligaments of the tongue; and they adhere a little to the lower part of the musculus pterygoideus internus, or anterior.

The tongue is the organ of the sense called the *tassa*, by means of the papillæ, especially the villosæ or pyramidales.

The tongue is likewise one of the principal instruments of speech, and of the articulation of the voice.

The tongue serves also to collect all the morsels which we chew, to turn them in different manners, and to different parts of the mouth, and to rub off whatever sticks to the palate; and it is useful in spitting, sucking, &c. It bears a great part in deglutition, being assisted by the digastric muscles, which, by contracting at the same time that the other muscles press the lower jaw against the upper, raise the os hyoides, and fix it at a convenient height, that the stylo-glossi and hyo-glossi may make the basis of the tongue bear back upon the morsel which is to be swallowed, and to force it into the pharynx, the portions of which that are at that time immediately above the morsel, do instantly contract, and push it into the œsophagus.

#### THE CHEEKS, LIPS, AND GUMS.

The cheeks and lips form the sides and entry of the cavity of the mouth. They are formed in general by the connection of several fleshy portions of different breadths, fixed round the convex sides of the two jaws, covered on the outside with the skin and fat, and lined on the inside by a glandulous membrane. Besides all this, the lips seem likewise to have a soft spongy substance in their composition, which swells and subsides on certain occasions independently of the action of the muscles belonging to them, and is mixed with fat.

The substance which forms the red border of the lips is very different from the rest of the skin, being a collection of very fine, long, villous papillæ, closely connected together, and covered by a fine membrane, which seems to be both a continuation of the epidermis, and of that pellicle which covers the glandulous membrane of the cavity of the mouth. This substance is extremely sensible, and very painful when the outer membrane is by any accident destroyed. The internal membrane of the upper lip forms a small middle frænum above the first dentes incisarii.

The gums are that reddish substance like leather, which covers the two sides of the whole alveolar border of both jaws, insinuates itself between all the teeth, surrounds the collar of each tooth in particular, and adheres very strongly to them. Therefore the outer and inner gums are continuous, and both together form just as many openings as there are teeth.

The substance of the gums is of a very singular structure, resembling in some measure the texture of a hat, supposed to be very compact and elastic. It is not immediately fixed to the bones of the jaws, but by the inter-

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vention of the periosteum, with which it is perfectly united; and it is covered by a fine, strong, even membrane, which sticks very close to the substance of the gums, and seems to be a continuation of that thin membrane which goes to the lips and cheeks, and of that which goes to the tongue.

There is so much variety to be met with in the muscles of the lips in different subjects, that it is not at all surprising to find the descriptions given of them by anatomists very unlike one another. In some subjects, portions of these muscles are wanting; in some they can scarcely be distinguished, because of the paleness and attenuation of the fibres; and in others there are really some particular fasciculi which are not generally to be found.

The muscles of the lips are commonly divided into common and proper. The common muscles are those which end at the angles and commissures of the two lips; and those are proper which are fixed in one lip only, which are again subdivided into the proper muscles of the upper lip, and proper muscles of the under lip. All these muscles have particular names, some of which are taken from something in the conformation of the muscles, some from the insertions or situation, and some from the uses attributed to them.

The semi-orbitales are commonly looked upon as one muscle, surrounding both lips, from whence it is called *orbicularis*; but when we examine carefully the angles of the lips, we find that the fibres of the upper lip intersect those of the under lip, and we easily distinguish the muscular arch of one lip from that of the other; and for this reason this muscle should be divided into two, *viz.* *orbicularis* or *semi-orbicularis superior*, and *semi-orbicularis inferior*.

The superior semi-orbicular muscle is oftentimes broader than the inferior; and it has this peculiarity likewise, that all its fibres do not go to the corner of the mouth, but terminate by degrees between the middle and extremities of this arch. The inferior semi-orbicular muscle is commonly more uniform in the disposition of its fibres.

The supra-semi-orbitales are fibres which increase the breadth of the two lateral portions of the superior semi-orbicularis, upward; and they appear at first sight to be one continued arch like the muscle last named. Their other extremities are confounded with those of the semi-orbicularis superior.

The buccinatores are two in number, each of them situated transversely between the posterior part of the two jaws, and the corner of the mouth. They are broad backward, and narrower forward, in the shape of a triangle or trapezium, and they form a considerable portion of the cheeks, and for that reason are sometimes called the *muscles of the cheeks*. To have a just idea of these muscles, we must be made acquainted with the ligamentum inter-maxillare, on each side of the face, because it connects the two jaws, and also gives insertion to the posterior fibres of the buccinator.

This ligament is strong and pretty broad. It is fixed by one end to the outside of the upper jaw, above the last dens molaris, and at the side of the apophysis pterygoidea, where it adheres very closely to the musculus pterygoi-

dæus internus. By the other end it is fixed in the posterior or superior extremity of the oblique prominent line on the outside of the lower jaw, below the last dens molaris. It serves likewise as a frænum to check and limit the depression of the lower jaw in opening the mouth.

The buccinator is inserted posteriorly in three different places. The middle fibres are fixed transversely in the ligamentum intermaxillare, and run directly to the corner of the mouth. The superior fibres run down in an oblique graduated manner, from the alveoli of the upper jaw to the corner of the mouth; and the inferior fibres run up from the lower jaw in the same manner. All these fibres contract by degrees as they approach the commissure of the lips, where they run in behind the extremities and union of the semi-orbitales; by which they are covered, and to which they adhere closely. There is a large hollow between this muscle and the masseter, filled with fat.

The zygomatici majores are two muscles situated, one on each side, between the zygoma and the corner of the mouth. Each muscle is thin, long, oblique, and fixed by one extremity to the lower edge of that portion of the os maxilæ, which is connected with the zygomatic apophysis of the os temporis. From thence it runs down obliquely from behind forward, being in its passage commonly involved in fat. It ends at the commissure of the two lips, adhering strongly to the buccinator which covers it.

The zygomatici minores are two small slender muscles, lying above the great zygomatici, and almost parallel to them. Their superior extremity seems to be a detachment from the lower fibres of the orbicularis palpebrarum; but they may always be distinguished. Their lower extremity unites with the neighbouring incisiformis. These muscles are quite buried in fat, and, for that reason, often disappear.

Each of the two canini is fixed by a broad insertion in the upper jaw, above the socket of the dens caninus, in a depression below the inferior edge of the orbit near the os maxilæ. From thence it runs down a little obliquely; crossing the lower extremity of the zygomaticus major, which covers it at this place. Afterwards it terminates at the extremity of the arch of the semi-orbicularis superior, and communicates by some fibres with the triangularis.

Each of the two incisorii laterales is a sort of biceps, its upper part being divided into two portions which unite below. One of these superior portions is larger than the other, and is fixed in the os maxillare below the middle tendon of the orbicularis palpebrarum. From thence it runs down a little obliquely toward the cheek, along the apophysis nasalis, mixing with the pyramidalis nasi, and sending some fibres to the nares. Afterwards it passes over and adheres to the myriformis, or transversalis nasi, and unites with the other portion.

This other portion is fixed by a broad insertion, immediately below the edge of the orbit, in the os maxillare, near the union of this bone with the os maxilæ, and likewise a little in the last named bone, being at this place covered by the inferior portion of the orbicularis palpebrarum. From thence it runs down obliquely toward the nose, and unites with the first portion.

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The two portions, thus united and contracted in breadth, run behind the semi-orbicularis superior, and are fixed therein opposite to the lateral dens incisivus.

The *laciforii medii* are two small short muscles, situated near each other, below the septum narium. They are fixed by one extremity in the os maxillare, on the alveoli of the first incisores behind the semi-orbicularis superior; and, by their other extremity, in the middle and superior part of the substance of the upper lip, near the nares, in which they likewise have an insertion.

Each of the two *triangulares* is fixed by a broad extremity, in the outside of the basis of the lower jaw, from the masseter, to the hole near the chin: From thence it ascends, contracting in breadth in a bent triangular form, runs in between the extremities of the buccinator and zygomaticus major; to both which it adheres very closely, and terminates at the commissure of the lip, partly in the semi-orbicularis superior, and partly in the semi-orbicularis inferior.

The *quadratus* forms the thick part of the chin below the under lip. It is first of all inserted in the fore-side of the lower jaw, where it partly fills the broad fossula on each side of the symphysis. From thence it runs up, intersecting, along the symphysis, the contiguous fibres of the skin, and terminates by a broad insertion in the semi-orbicularis inferior.

The *incisorii inferiores* are two small muscles, each of them fixed by the superior extremity on the alveoli of the lateral incisores of the lower jaw. From thence they run down, approaching each other, and are inserted together in the lower part of the middle of the semi-orbicularis inferior.

The two *musculi cutanei* form a kind of fleshy membrane, which covers the whole fore-side of the throat and neck, from the cheek and chin, all the way down below the clavicular.

The fibres of each cutaneous muscle run obliquely upward and forward, and meet, and seem to intersect those of the other muscle at acute angles, from the sternum all the way to the chin. They adhere very closely to the skin by the intervention of the cellular substance. From the clavicles to the upper part of the neck these muscles are very thin, and from thence increase a little in thickness as they approach the basis of the lower jaw, and especially from the masseter to the chin.

They adhere strongly to the lower portion of the masseter, *triangularis*, and *quadratus*, and on the masseter and buccinator their fleshy fibres become aponeurotic, but continue longer on the *triangularis*, being mixed with the fibres of that muscle all the way to the commissure of the lips. They likewise advance a little on the neighbouring portion of the *quadratus*.

The common muscles of the lips either draw both corners of the mouth at once, or only one at a time, according to the different direction of their fibres. The proper muscles pull the different parts of the lips in which they are inserted. The buccinators in particular may serve to move the food in mastication. An intire treatise might be written on the almost innumerable combinations of the different motions of all these muscles, according to the different passions, and according to the

different postures in which a man may put his face. None are more affecting, than those produced by the cutanei alone, especially in weeping, which they do by their adhesions to the *triangulares*, &c. But by their insertions in the bone of the lower jaw, they draw up the lower part of the integuments of the neck, and those of the breast next to these; for they cannot move the jaw.

### THE SALIVAL GLANDS.

By saliva we mean, in general, that fluid by which the mouth and tongue are continually moistened in their natural state. This fluid is chiefly supplied by glands, called, for that reason, *glandule salivales*, of which they commonly reckon three pairs, two parotides, two maxillares, and two sublinguales. These are indeed the largest, and they furnish the greatest quantities of saliva; but there are a great number of other lesser glands of the same kind, which may be reckoned assistants or substitutes to the former.

The parotides are two large, whitish glands, irregularly oblong and protuberant, situated on each side, between the external ear, and the posterior or ascending ramus of the lower jaw, and lying on some part of the neighbouring masseter muscle. The superior portion of this gland lies before the cartilaginous meatus of the ear, and touches the apophysis zygomatica of the os temporis; and it is extended forward and backward under the lobe of the ear, as far as the mastoid apophysis.

From the anterior and superior portion of this gland, a white membranous duct or canal is produced by the union of a great number of small tubes representing so many roots. This duct runs obliquely forward on the outside of the masseter, and then perforates the buccinator from without inward, opposite to the interstice, between the second and third dentes molares, where the hole or orifice represents the spout of an ewer.

This canal is named *ductus salivalis Stenonis*, or *ductus superior*. It is about the twelfth part of an inch in diameter. The arteria and vena angularis run up over this duct, and the portio dura of the auditory nerve runs through the gland itself; and it also receives filaments from the second vertebral pair.

The maxillary glands are smaller and rounder than the parotides, and are situated each on the inside of the angle of the lower jaw, near the musculus pterygoidæus inferior. From the inside, or that which is turned to the musculus hyo-glossus, each of them sends out a duct in the same manner as the parotides, but it is smaller and longer, and goes by the name of *ductus salivalis Whartonii*, or *ductus inferior*.

This duct advances on the side of the musculus genio-glossus, along the inner part and superior edge of the glandula sublingualis, to the frænum of the tongue, where it terminates by a small orifice in form of a papilla.

The glandule sublinguales are likewise two in number, of the same kind with the former, only smaller, something oblong, and flattened like a blanched almond. They are situated under the anterior portion of the tongue, one on each side, near the lower jaw, on the lateral por-

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tions of the musculus mylo-hyoidæi which sustain them. They are covered on the upper side by a very thin membrane, which is a continuation of the membrane that covers the under side of the tongue. They send out laterally several small short ducts which open near the gums by the same number of orifices, all ranked in the same line, at a small distance from the frænum, and a little more backward.

The molares are two glands nearly of the same kind with the former, each of them being situated between the masseter and buccinator; they send out small ducts which perforate the buccinator, and open into the cavity of the mouth, almost over against the last dentes molares.

All the inside of the cheeks near the mouth, is full of small glandulous bodies, called *glandula buccales*, which open by small holes or orifices through the inner membrane of the mouth. The membrane which covers the inside of the lips, a continuation of that on the cheeks, is likewise perforated by a great number of small holes, which answer to the same number of small glands, called *glandula labiales*. The *glandula linguales* are those of the foramen cæcum of the basis of the tongue.

The *glandula palatinæ*, or those that belong to the arch and septum of the palate, have already been described, and the *glandula arytеноидææ* were described with the larynx. The uvular glands are only a continuation of the membrane of the palate in form of a small bunch of grapes.

The amygdalæ are two glandular bodies of a reddish colour, lying in the interstices between the two lateral half arches of the septum palati, one on the right, the other on the left side of the basis of the tongue. Their appearance is not unlike that of the outside of an almond-shell, both because their surface is uneven, and because it is full of holes big enough to admit the head of a large pin.

These holes, which represent a sieve, or a piece of network, are continued to an irregular sinus or cavity within the gland, filled commonly with a viscid fluid, which comes from the bottom of the sinus, and is from thence gradually discharged through these holes into the throat.

The thyroid gland is a large whitish mass which covers the anterior convex side of the larynx. It seems at first sight to be made up of two oblong glandular portions, united by their inferior extremities, below the cricoid cartilage, in such a manner as to have some resemblance to a crescent, with the cornua turned upward. It is of a moderate thickness, and bent laterally like the thyroid cartilage, from which its name is taken. The two lateral portions lie on the musculus thyro-hyoidæi, and the middle or inferior portion on the crico-thyroidæi. The thyro-pharyngæi inferiores send fibres over this gland, and they communicate on each side by some such fibres with the sterno-thyroidæi and hyo-thyroidæi.

### GLANDULÆ LYMPHATICÆ.

BELOW each of the first salival glands above described, or parotids, toward the mastoid apophysis, is fixed a small gland of another kind, differing from the former in si-

gure, colour, excretory duct, and in the fluid which it secretes. It is round, and of an even surface, without tubercles; and it is the uppermost of a great number of glands of the same kind, which lie partly below the interstices between the parotid and maxillary glands, and at different distances, along the internal jugular vein, all the way to the lower part of the neck. We observe among these glands, and upon this vein, a great number of transparent vessels, with an appearance of numerous valves. The fluid which they contain is transparent, a little mucilaginous, and is called *lymphæ*.

These vessels are likewise termed *lymphatic vessels*, and the glands *lymphatic glands*. These glands are not all equally large, nor equally round, some being oblong, thick, flat, small, &c. The lymphatic vessels go out alternately by one extremity from one gland, and enter by the other extremity some other gland near the former, and both as they go out, and as they enter these extremities, are very much ramified. The trunk is commonly single; and the valves are so disposed, as that the fluid contained in the vessel can only run toward the thorax, but cannot return to the head.

These glands and vessels are to be found in many other parts of the body. We meet with them not only in several parts of the head, but also in many outward and inward parts of the thorax, abdomen, and both extremities. They accompany the maxillary salival glands, as well as the parotids; and there are several spread on the lateral and back sides of the neck, in the membrana adiposa, near the muscles.

In the cavity of the thorax, the lymphatic glands are situated at different distances on one side, and behind the œsophagus, especially at the place which is even with the fifth vertebra of the back. There are some on the anterior portion of the diaphragm, on one side of the mediastinum; and there are others round the basis of the heart, in the fat which lies there. They are to be met with likewise in the substance of the membrana adiposa which covers the thorax, near the inner surface, especially about the clavicles, and in the cellular interstices of the muscles which lie on the thorax.

In the cavity of the abdomen these glands are very numerous, and particularly round the superior orifice, and on the two curvatures of the stomach; on the capsula of the sinus of the vena portæ; on the cellular ligament of the vesicula fellis; near the beginning of the ductus cysticus; at the adhesions of the omentum to the spleen, and to the colon; through the whole extent of the mesentery; at the adhesions of the mesocolon; behind the adhesions of these two membranes to the vertebræ of the loins; near the bifurcation of the aorta; and along the iliac vessels. There are likewise other such glands on the outside of the abdomen, in the substance, and toward the inside of the membrana adiposa.

In the superior extremities of the body these glands lie chiefly under the articulation of the os humeri with the scapula, in the hollow of the axilla. The most considerable lymphatic glands in the lower extremity are toward the lower part of the inguina, commonly called the *inguinal glands*, to which the fascia lata, or crural aponeurosis, gives a kind of double capsula, which makes  
some

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Fig. 3.



Fig. 1.



Fig. 6.

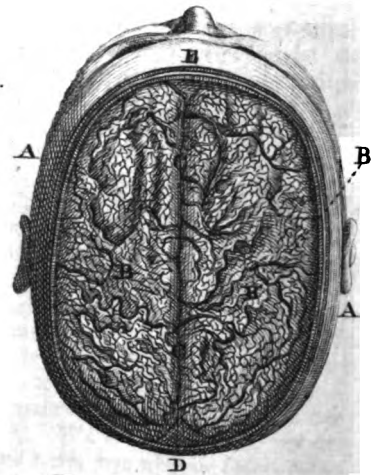


Fig. 2.

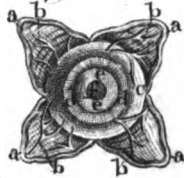


Fig. 7.

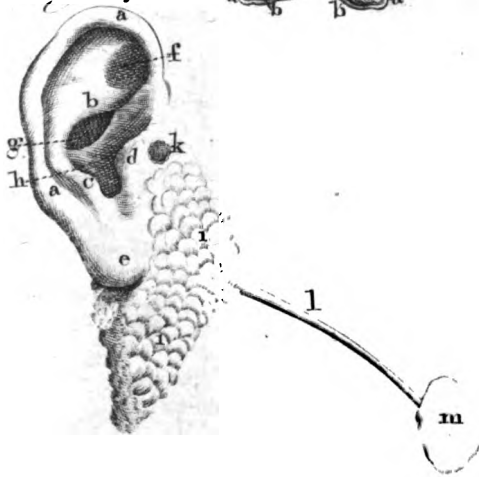


Fig. 4.

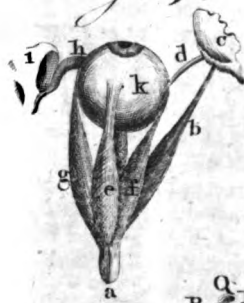


Fig. 5.

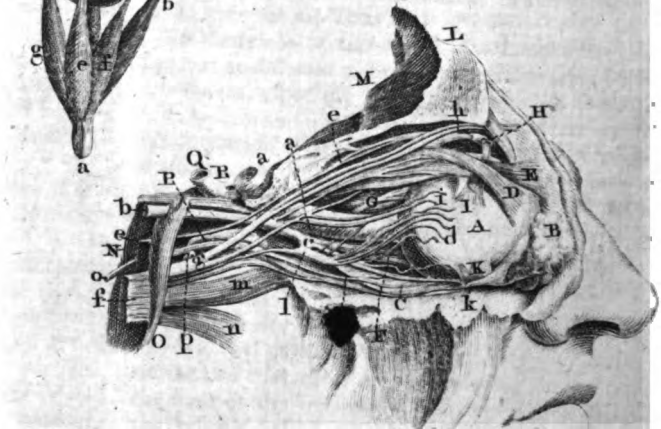


Fig. 10.

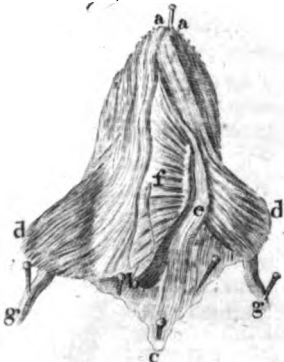


Fig. 9.

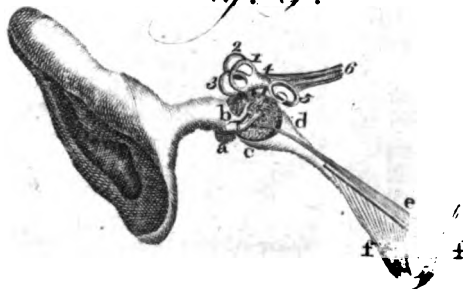
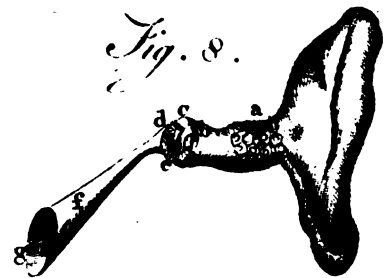


Fig. 8.



some of them lie very near the skin, and the rest at a greater distance from it.

As these lymphatic glands differ more in situation than in size or figure, they are commonly enumerated and denominated from the places where they lie; *e. g.*

Glandulæ parotides lymphaticæ,  
Glandulæ maxillares lymphaticæ,  
Glandulæ jugulares, &c.

The lymphatic vessels were discovered more than an hundred years ago. But their nature and origin were not understood till Dr Alexander Monro, present Professor of Anatomy in the University of Edinburgh, published his treatise, *De Venis Lymphaticis Valvulosis*, in the year 1757. In this treatise the Doctor has proved, by many accurate experiments, That the lymphatic vessels are a system of absorbents: That they are not continuations of the arteries or veins; but that they are a distinct system of vessels, destined for absorbing a pellucid liquor called *lymph*, from the different cavities of the body, &c. and for transmitting it to the blood, by the contraction

of their coats, and the pressure of the neighbouring parts.

Besides these vessels which accompany the glands, there are others of the same structure found on the several viscera, where no lymphatic glands have hitherto been discovered. We meet with them in very great numbers in the external membrane of the liver, and in the duplicature of the superior membranous ligament of this viscus.

Another sort of vessels termed *lymphatics*, are the small arteries and veins, which, in the natural state, transmit only the serous part of the blood. These vessels differ from the absorbent lymphatics in the smallness of their diameter, and in their structure and situation. All these little arteries and veins are uniform, extremely narrow; and though their sides are not thinner than those of the valvular lymphatics, yet their diameters are generally less. The other lymphatics are full of valves, and very thin, but they are not narrow in proportion. The arterial and venal lymphatics are found on the parts which are naturally white, as on the skin, the white of the eye, &c.

## EXPLANATION OF PLATE XXI.

FIGURE 1. Shews the lachrymal canals, after the common teguments and bones have been cut away.

a, The lachrymal gland. b, The two puncta lachrymalia, from which the two lachrymal canals proceed to c, the lachrymal sac. d, The large lachrymal duct. e, Its opening into the nose. f, The caruncula lachrymalis. g, The eye ball.

FIG. 2. An anterior view of the coats and humours of the eye.

a a a a, The tunica sclerotica cut in four angles, and turned back. b b b b, The tunica choroides adhering to the inside of the sclerotica, and the ciliary vessels are seen passing over—c c, The retina, which covers the vitreous humour. d d, The ciliary processes, which were continued from the choroid coat. e e, The iris. f, The pupil.

FIG. 3. Shews the optic nerves, and muscles of the eye.

a a, The two optic nerves before they meet. b, The two optic nerves conjoined. c, The right optic nerve. d, Musculus attollens palpebræ superioris. e, Attollens oculi. f, Abductor. g g, Obliquus superior, or trochlearis. h, Adductor. i, The eye-ball.

FIG. 4. Shews the eye-ball with its muscles.

a, The optic nerve. b, Musculus trochlearis. c, Part of the os frontis, to which the trochlea or pulley is fixed, through which,—d, The tendon of the trochlearis passes. e, Attollens oculi. f, Adductor oculi. g, Abductor oculi. h, Obliquus inferior. i, Part of the superior maxillary bone to which it is fixed. k, The eye-ball.

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FIG. 5. Represents the nerves and muscles of the right eye, after part of the bones of the orbit have been cut away.

A, The eye-ball. B, The lachrymal gland. C, Musculus abductor oculi. D, Attollens. E, Levator palpebræ superioris. F, Depressor oculi. G, Adductor. H, Obliquus superior, with its pulley. I, Its insertion into the sclerotic coat. K, Part of the obliquus inferior. L, The anterior part of the os frontis cut. M, The crista galli of the ethmoid bone. N, The posterior part of the sphenoid bone. O, Transverse spinous process of the sphenoid bone. P, The carotid artery, denuded where it passes thro' the bones. Q, The carotid artery within the cranium. R, The ocular artery.

NERVES.—a a, The optic nerve. b, The third pair.—c, Its joining with a branch of the first branch of the fifth pair, to form l, The lenticular ganglion, —which sends off the ciliary nerves. d. e e, The fourth pair. f, The trunk of the fifth pair. g, The first branch of the fifth pair, named ophthalmic.—h, The frontal branch from it. i, Its ciliary branches, along with which the nasal twig is sent to the nose. k, Its branch to the lachrymal gland. l, The lenticular ganglion. m, The second branch of the fifth pair, named superior maxillary. n, The third branch of the fifth pair, named inferior maxillary. o, The sixth pair of nerves,—which sends off p, The beginning of the great sympathetic. q, The remainder of the sixth pair, spent on c, The abductor oculi.

FIG. 6. Represents the head of a youth, where the upper part of the cranium is sawed off,—to shew the upper part of the brain, covered by the pia mater, the vessels of which are minutely filled with wax.

A A, The cut edges of the upper part of the cranium.

† 4 I

B, The

B, The two tables and intermediate diploe. BB, The two hemispheres of the cerebrum. CC, The incisure made by the falx. D, Part of the tentorium cerebello super expansum. E, Part of the falx, which is fixed to the crista galli.

FIG. 7. Represents the parts of the external ear, with the parotid gland and its duct.

a a, The helix. b, The anthelix. c, The antitragus. d, The tragus. e, The lobe of the ear. f, The cavitas innominata. g, The scapha. h, The concha. i i, The parotid gland. k, A lymphatic gland, which is often found before the tragus. l, The duct of the parotid gland. m, Its opening into the mouth.

FIG. 8. A view of the posterior part of the external ear, meatus auditorius, tympanum, with its small bones, and Eustachian tube of the right side.

a, The back part of the meatus, with the small ceruminous glands. b, The incus. c, Malleus. d, The

chorda tympani. e, Membrana tympani. f, The Eustachian tube. g, Its mouth, from the fauces.

FIG. 9. Represents the anterior part of the right external ear, the cavity of the tympanum—its small bones, cochlea, and semi-circular canals.

a, The malleus. b, Incus with its long leg, resting upon the stapes. c, Membrana tympani. d, e, The Eustachian tube, covered by part of—f f, The musculus circumflexus palati. 1, 2, 3, The three semi-circular canals. 4, The vestibule. 5, The cochlea. 6, The portio mollis of the seventh pair of nerves.

FIG. 10. Shews the muscles which compose the fleshy substance of the tongue.

a a, The tip of the tongue, with some of the papillæ minimæ. b, The root of the tongue. c, Part of the membrane of the tongue, which covered the epiglottis. d d, Part of the musculus hyo-glossus. e, The lingualis. f, Genio-glossus. g g, Part of the stylo-glossus.

## A N C

**ANATOMY** is also used, in a less proper sense, for the analysing of compound bodies. See **ANALYSIS**.

**ANATOMY**, in some old statutes, is used to denote the subject to be anatomized.

**ANATOMY**, in a figurative sense, is sometimes used for a strict examination of an affair, discourse, or performance.

**ANATOMY of plants.** See **AGRICULTURE**, Part I.

**ANATORIA**, a small city of Greece, upon the river Afopa, five miles from the straits of Negropont.

**ANATRON**, **NATRON**, or **NATRUM**, in natural history. See **NATRUM**.

**ANAUDIA**, a term used by some writers to denote dumbness, or the want of the use of speech.

**ANAXAGORIA**, in Grecian history, an anniversary festival, kept, in honour of Anaxagoras, by the people of Lampfacus.

**ANAXIMANDRIANS**, in the history of philosophy, the followers of Anaximander; the most ancient of the philosophical atheists, who admitted of no other substance in nature but matter.

**ANAZZO**, a town in the province of Barri, in the kingdom of Naples.

**ANBAR**, a city of Asia, situated upon the Euphrates, twenty leagues from Bagdat. It is called by the natives *Hajchemiah*.

**ANBURY**, among farriers. See **AMBURY**.

**ANCAMARES**, a people of S. America, along the river Madeira, which afterwards falls into the river of the Amazons.

**ANCARANO**, a small city of the ecclesiastical state, in the marquise of Ancona.

**ANCASTER**, a town of Lincolnshire, near Lincoln, W. long. 30°. N. lat. 52° 50'.

## A N C

**ANCENIS**, a town of France, in the province of Brittany, W. long. 1° 9'. N. lat. 47° 20'.

**ANCESTORS**, those from whom a person is descended in a straight line.

**ANCESTREL**, in law, something that relates to, or has been done by one's ancestors.

**ANCHIALUS**, a city of Thrace, upon the Euxine sea, by the Turks called *Kiphis*, and by the Greeks *Anchio*.

**ANCHILOPS**, in medicine, a small tumor in the great angle of the eye, frequently degenerating into an abscess or fistula lachrymalis.

**ANCHIO**, in geography. See **ANCHIALUS**.

**ANCHOR**, in maritime affairs, an extremely useful instrument, serving to retain a ship in its place.

It is a very large and heavy iron instrument, with a double hook at one end, and a ring at the other, by which it is fastened to a cable. It is cast into the bottom of the sea, or rivers; when, taking its hold, it keeps ships from being drawn away by the wind, tide, or currents.

The parts of an anchor are, 1. The ring to which the cable is fastened. 2. The beam or shank, which is the longest part of the anchor. 3. The arm, which is that which runs into the ground. 4. The flouke or fluke, by some called the *palm*, the broad and peaked part, with its barbs, like the head of an arrow, which fastens into the ground. 5. The stock, a piece of wood fastened to the beam near the ring, serving to guide the fluke, so that it may fall right and fix in the ground.

There are several kinds of anchors: 1. The sheet-anchor, which is the largest, and is never used but in violent storms, to hinder the ship from being driven a-shore.



a-shore. 2. The two bowers, which are used for ships to ride in a harbour. 3. The stream anchor. 4. The grapnel. See STREAM-ANCHOR, and GRAPNEL.

The shank of an anchor is to be three times the length of one of its flukes; and a ship of 500 tons hath her sheet-anchor of 2000 weight; and so proportionably for others, smaller or greater. The anchor is said to be *a-peak*, when the cable is perpendicular between the hawse and the anchor. See HAWSE.

An anchor is said to *come home*, when it cannot hold the ship. An anchor is *soul*, when, by the turning of the ship, the cable is hitched about the fluke. To *shoe* an anchor, is to fit boards upon the flukes, that it may hold the better in soft ground. When the anchor hangs right up and down by the ship's side, it is said to be a *cock-bell*, upon the ship's coming to an anchor.

The inhabitants of Ceylon use large stones instead of anchors; and in some other places of the Indies, the anchors are a kind of wooden machines, loaded with stones.

ANCHOR, in architecture, a sort of carving, something resembling an anchor. It is commonly placed as part of the enrichments of the bouldins of capitals of the Tuscan, Doric, and Ionic orders; and also of the bouldins of bed-mouldings of the Doric, Ionic, and Corinthian cornices; anchors and eggs being carved alternately through the whole building.

ANCHOR, in heraldry, are emblems of hope, and are taken for such in a spiritual, as well as a temporal sense.

ANCHORAGE, or ANCHORING-GROUND, a place where a ship may cast anchor.

The best anchoring-ground is stiff clay or hard sand; and the best place for riding at anchor is, where a ship is land-locked, and out of the tide.

ANCHORAGE, in law, is a duty upon ships for the use of the port or harbour where they cast anchor.

ANCHORALIS *processus*. See CORACOIDES.

ANCHORED, or ANKERED, is said of a cross, the four extremities of which resemble the flukes of an anchor.

The cross resembles very much the cross-moline; the whole difference between them consisting only in this, that the anchored cross is somewhat sharper at the points than the moline. See MOLINE.

ANCHOVY, in ichthyology, the English name of the *clupea encrasicolus*. See CLUPEA.

ANCHUSA, or ALKANET, in botany, a genus of the pentandria monogynia class. The corolla is shaped like a tunnel. There are eight species of the anchusa; viz. 1. The officinalis, a native of France and the warmer parts of Europe. The root of the officinalis is not now used in medicine; its principal use is for colouring oils, unguents, plasters, &c. 2. The angustifolia, a native of Italy and Germany. 3. The undulata, a native of Spain. 4. The orientalis, a native of the E. Indies. 5. The virginiana, a native of Virginia. 6. The lanata, a native of Algiers. 7. The tinctoria, a native of Montpellier. 8. The

sempervirens, or ever-green alkanet, a native of Britain and Spain.

ANCHYLOBLEPHARON, among physicians, denotes a cohesion of the eye-lids.

ANCIENT. See ANTIENT, and ANTIQUITY.

ANCIENTLY, in some old statutes, a term used to denote seniority.

ANCLABRIS, in Roman antiquity, the table whereon the priests eat their portion of the sacrifices.

ANCLAM, a town of Pomerania in Germany, situated on the river Pene, in E. long. 14°, and N. lat. 54°, about 45 miles N. W. of Stetin.

ANCLE, in anatomy. See TALUS.

ANCOBER, or RIO-COBRE, a river on the coast of Guinea in Africa.

ANCILIA, in antiquity. See ANCYLE.

ANCON. See OLECRANON.

ANCONA, a sea-port town of Italy, situated on the gulph of Venice, in E. long. 15°, and N. lat. 43° 20'.

It is the capital of a marquissate of the same name, subject to the pope.

ANCONÆUS, in anatomy, one of the muscles of the elbow. See ANATOMY, p. 197.

ANCONES, in architecture, the corners or coins of walls, cross-beams, or rafters.

ANCONY, in mineralogy, denotes a bloom of iron fashioned into a flat bar about three feet long, with a square rough knot at each end.

ANCRE, a town of Picardy in France, upon a river of the same name, between Corbic and Bapaume.

ANCRE'E, in heraldry, the same with anchored. See ANCHORED.

ANCUAH, a city of the province of Alovahat, in the northern parts of Egypt.

ANCUBITUS, among ancient physicians, a term to denote that affection of the eyes in which they seemed to contain sand.

ANCUD, a province of Chili in S. America, having on the west the Archipelago of the same name; the Andes on the east; the country of Osorno on the north; and the country of Magellan on the south.

ANCYLE, in antiquity, a kind of shield that fell, as was pretended, from heaven, in the reign of Numa Pompilius; at which time, likewise, a voice was heard, declaring that Rome should be mistress of the world as long as she should preserve this holy buckler. It was kept with great care in the temple of Mars, under the direction of twelve priests; and lest any should attempt to steal it, eleven others were made so like, as not to be distinguished from the sacred one. These ancylæ were carried in procession every year round the city of Rome.

ANCYLE, in surgery, a distortion of the joints.

ANCYLOGLOSSUM, among physicians, denotes a contraction of the ligaments of the tongue, hindering speech.

ANCYLOMELE, a surgeon's crooked probe. See PROBE.

ANCYLOSIS, in surgery. See ANCYLE.

ANCYROIDES, among anatomists. See CORACOIDES.

ANCZAK.

**ANCZAKRICH**, a river of Podolia, which falls into the Black Sea, near Oczakow.

**ANDABATÆ**, in antiquity, a sort of gladiators who, mounted on horseback or in chariots, fought hood-winked, having a helmet that covered their eyes.

**ANDALUSIA**, the most south-west province of Spain, having Estremadura and New Castile on the north; and Granada, the Straits of Gibraltar, and the Atlantic Ocean, on the south.

*New* **ANDALUSIA**, a province of Terra Firma, lying on the coast of the Atlantic Ocean, opposite to the Leeward islands, having the river Oroonoco on the west.

**ANDAMAN**, the name of some small islands situated on the east side of the entrance of the bay of Bengal, in E. long. 92°, and N. lat. 15°.

**ANDANAGAR**, a town of the peninsula in India, on this side the Ganges, in the kingdom of Decan.

**ANDANCE**, a town of Languedoc in France, situated near the confluence of the Rhone and the Dome.

**ANDANTI**, in music, signifies, especially in thorough-basses, that the notes are to be played distinctly.

**ANDAYE**, a town in France, upon the Spanish frontiers, within two leagues of St Jean de Luz.

**ANDELI**, a town of Normandy in France, situated upon the Seine, between Paris and Rouen.

**ANDENA**, in old writers, denotes the swath made in mowing of hay, or as much ground as a man could stride over at once.

**ANDENES**, an island in the north sea, upon the coast of Norway. It is only inhabited by fishermen.

**ANDERENÆ sal**, a name sometimes used for the natrum of the ancients. See **NATRUM**.

**ANDERLECHT**, a fortress of the Austrian Netherlands, about two miles south of Brussels.

**ANDERNACHT**, a city of Germany, situated on the Lower Rhine, in E. long. 7°, and N. lat. 50° 25', about 30 miles south of Cologne.

**ANDERO**, a sea-port town of Spain, in the province of Biscay, about sixty miles west of Bilboa, situated in W. long. 4° 30', and N. lat. 43° 20'. Here the Spaniards build and lay up some of their men of war.

**ANDES**, a vast ridge of mountains which runs almost the whole length of S. America. They are esteemed the highest in the world, being covered with snow in the warmest climates; and from thence called the *Sierras Nevada*, or the *snowy mountains*.

**ANDEVALLO**, a small country of Spain, in Andalusia, upon the frontiers of Portugal and Spanish Estremadura.

**ANDEUSE**, a city of Languedoc in France, situated in E. long. 3° 40', and N. lat. 43° 45'.

**ANDORINHA**, in ornithology, an obsolete name of the hirunda. See **HIRUNDA**.

**ANDOVER**, a large market-town in Hampshire, situated about ten miles north-west of Winchester, in W. long. 1° 30', and N. lat. 51° 20'. It sends two members to parliament.

**ANDRACHNE**, in botany, a genus of the monœcia gynandria class. The calix of the male consists of five leaves; the corolla has five petals; and the stamina, which are also five in number, are inserted into

the stylus. The calix of the female is divided into five leaves; it has no corolla; the styli are three; the capsule is trilocular, containing two seeds. There are only two species of the andrachne, viz. the telepheoides, a native of Italy; and the fruticosa, a native of China.

**ANDREJOS**, a town situated near the Boristhenes, between Muscovy and Poland.

**ANDREW**, or, *Knights of St ANDREW*, an order of knights, more usually called the order of the thistle. See **THISTLE**.

*Knights of St ANDREW* is also an order instituted by Peter the Great of Muscovy in 1698; the badge of which is a golden medal, on one side whereof is represented St Andrew's cross, with these words, *Cazar Pierre monarque de tout la Russie*. This medal, being fastened to a blue ribbon, is suspended from the right shoulder.

*St ANDREW's cross*, one in form of the letter X. See **CROSS**.

*St ANDREW's-day*, a festival of the Christian church, celebrated on the thirteenth of November, in honour of the apostle St Andrew.

**St ANDREWS**, in geography, a town in the county of Fife in Scotland, situated on the German Ocean, in W. long. 2° 25', and N. lat. 56° 20', about 30 miles N. E. of Edinburgh.

St Andrews was formerly an archbishop's see, but at present is chiefly remarkable on account of its university.

**St ANDREWS** is also the name of a town of Carinthia in Germany, situated in E. long. 15°, and N. lat. 47°, about a hundred miles south of Vienna.

**ANDRIA**, in Grecian antiquity, public entertainments first instituted by Minos of Crete, and, after his example, appointed by Lycurgus at Sparta, at which a whole city or a tribe assisted. They were managed with the utmost frugality, and persons of all ages were admitted, the younger sort being obliged by the lawgiver to repair thither, as to schools of temperance and sobriety.

**ANDRIA**, among some naturalists, denotes an hermaphroditical woman. See **HERMAPHRODITE**.

**ANDRIA**, in geography, a town of Italy, in the kingdom of Naples, situated in E. long. 17°, and N. lat. 41° 6'. It is a bishop's see.

**ANDROAS**, or **ANDRODAMAS**, among ancient naturalists, a kind of pyritz, to which they attributed certain magical virtues.

**ANDROGYNOUS**, in zoology, an appellation given to animals which have both the male and female sex in the same individual.

**ANDROGYNOUS baths**, in antiquity, those common to both sexes. See **BATH**.

**ANDROIDES**, in mechanics, a human figure, which, by certain springs, performs several external functions of a man. See **AUTOMATON**.

**ANDROLEPSY**, in Grecian antiquity, an action allowed by the Athenians against such as protected persons guilty of murder. The relations of the deceased were empowered to seize three men in the city, or house whither the malefactor had fled, till he were either

either surrendered, or satisfaction made some other way for the murder.

**ANDROLEPSY** is sometimes also used to signify reprisals. See **REPRISAL**.

**ANDROMACHUS's treatise.** See **THERIACA**.

**ANDROMEDA**, in astronomy, a northern constellation, consisting of 27 stars, visible to the naked eye, behind Pegasus, Cassiopeia, and Perseus. See **ASTRONOMY**.

**ANDROMEDA**, in botany, a genus of the decandria monogynia class. The calix is divided into five parts; the corolla is ovated and quinquefid; and the capsule has five cells or divisions. There are nine species of the andromeda, viz. the tetragona, hypnoides, and cerulea, natives of Lapland and the Alps; the mariana, paniculata, arborea, and calyculata, natives of Virginia; the polifolia, marsh-cistus, or wild rosemary, a native of G. Britain; and the racemosa, a native of Pennsylvania.

**ANDRON**, in Grecian antiquity, denotes the apartment in houses designed for the use of men; in which sense, it stands opposed to gynæceum. See **GYNÆCEUM**.

**ANDRONION**, among ancient physicians, a name given to certain troches invented by Andron.

**ANDROPHAGI.** See **ANDROPOPHAGI**.

**ANDROPOGON**, in botany, a genus of the polygamia monocæcia class. This genus contains 18 species, viz. the caricofum, contortum, divaricatum, nutans, gryllus, insulare, ravennæ, alopecuroides, distachyon, schoenanthus, virginicum, bicornis, hirtum, nardus, muticum, ischoemum, fasciculatum, and polydactylon, most of them natives of the Indies.

**ANDROS**, an island in the Archipelago, near the south end of Negropont.

**ANDROSACE**, in botany, a genus of the pentandria monogynia class. The umbella of the androsace is inclosed in an involucre; the corolla is ovated; and the capsule is globular, and consists of one apartment. There are six species of this genus; viz. the maxima, a native of Austria; the septentrionalis, a native of Lapland, Russia, and the Alps; the villosa, a native of the Pyrenean mountains; the lactea, a native of Austria; the carnea, a native of Switzerland; and the elongata, a native of Austria.

**ANDROSÆMUM**, in botany, a synonyme of several species of hypericum. See **HYPERICUM**.

**ANDROMOTY**, or **ANDRANOTOMY**, the dissection of human bodies. See **ANATOMY**.

**ANDRUM**, a kind of hydrocele, to which the people of Malabar are very subject. See **HYDROCELE**, and **MEDICINE**.

**ANDRYALA**, in botany, a genus of the syngenesia polygamia æqualis class. The receptacle is villous; the calix is divided into many equal round pieces; and the pappus is simple and sessile. There are four species of the andryala, viz. the integifolia, a native of France and Sicily; the ragulina, a native of the Archipelagus; the sinuata, a native of Montpellier and Sicily; and the lanata, a native of the southern parts of Europe.

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**ANDUXAR**, a city of Andalusia in Spain, situated on the river Guadalquivir, about 32 miles east of Corduba, in W. long. 4°. and N. lat. 37° 50'.

**ANDUZE.** See **ANDEUSE**.

**ANEE**, in commerce, a measure for grain, used in some provinces of France. At Lyons, it signifies also a certain quantity of wine, which is the load an ass can carry at once: Which is fixed at 80 English quarts, wine measure.

**ANEGADA**, one of the Caribbee islands, situated in W. long. 63° 5' and N. lat. 18°.

**ANELE**, or **ANIL**, in our old statutes, names used for indigo. See **INDIGO**.

**ANEMABO.** See **ANNAMABOE**.

**ANEMIUS**, among chemists, an appellation given to a wind-furnace, used in making fire-furnaces for melting and distillation.

**ANEMOMACHIA**, a term used by ancient naturalists for a whirlwind or hurricane.

**ANEMOMETER**, among mechanical philosophers, an instrument contrived for measuring the strength of the wind.

**ANEMONE**, in botany, a genus of the polyandria polygynia class. It has no calix; the petals are from six to nine, and the seeds are numerous. There are 21 species of anemone, most of them natives of Europe, and only the nemorosa and pulsatilla are natives of Britain.

**ANEMOSCOPE**, a machine shewing from what point of the compass the wind blows. It denotes also an instrument invented to foretell the changes of the wind.

**ANET**, a town in the isle of France, upon the river Eure.

**ANETHUM**, in botany, a genus of the pentandria digynia class. The fruit is oval, compressed, and striated. There are only two species of anethum; viz. the graveolens, a native of Spain; and the feniculum, fennel, or finckle, a native of Britain. The seeds of the graveolens are recommended as a carminative. The best preparations of them are, the distilled oil, and a tincture or extract made with rectified spirit.

**ANEURISM**, or **ANEURYSM**, in surgery, a throbbing tumor, distended with blood, and formed by a dilatation or rupture of an artery. See **SURGERY**.

**ANFA**, a city of Africa, in the kingdom of Fez, situated on the sea-coast, between Rabat and Azamar.

**ANGAMALA**, a small city of India, situated upon the river Aicotta, on the Malabar coast.

**ANGARIA**, in Roman antiquity, a kind of public service imposed on the provincials, which consisted in providing horses and carriages for the conveyance of military stores, and other public burdens. It is sometimes also used for a guard of soldiers, posted for the defence of a place. In a more general sense, it is used for any kind of oppression, or services performed through compulsion.

**ANGASMAGO**, a river of S. America. During the reign of the Incas, it bounded the kingdom of Peru on the north, as the river Maule did on the south. See **PERU**.

**ANGEIOGRAPHY**, or **ANGEIOLOGY**, among anatomists,

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mists,

- mists, the description and history of the several vessels of the human body.
- ANGEIOGRAPHY**, among antiquarians, denotes the description of the various utensils, weights, measures, &c. of the ancients.
- ANGEIOTOMY**, in surgery, a term sometimes used for the opening of a vein or artery.
- ANGEL**, a name given to those spiritual intelligent beings, who are supposed to execute the will of God, in the government of the world.
- The existence of angels has been admitted in all religions. The Greeks and Latins acknowledged them under the name of *genii* or *demons*; and, in the alcoran, we find frequent mention of them, the Mahometans assigning them different orders and degrees, and different employments, both in heaven and earth.
- ANGEL** is likewise a title given to bishops of several churches. In this sense is St Paul understood by some authors, where he says, *Women ought to be covered in the church, because of the angels*; and thus, in the Revelation, *The seven stars are the angels, that is, bishops, of the seven churches*.
- ANGEL**, in commerce, the name of an ancient gold coin in England, of which some are still to be seen in the cabinets of the curious. It had its name from the figure of an angel represented upon it. It was  $23\frac{1}{2}$  carats, and weighed four penny-weights. Its value differed in different reigns.
- ANGEL-FISH**, in ichthyology. See **SQUALUS**.
- ANGELIC**, or **ANGELICAL**, an epithet given to whatever belongs to, or partakes of the nature of angels. See **ANGEL**.
- ANGELIC Art**. See **ART**.
- ANGELIC Habit**. See **HABIT**.
- ANGELICA**, in botany, a genus of the pentandria digynia class. The fruit of the angelica is roundish, with three furrows on each side; the corolla is equal, and the petals turned inward at the top. There are four species of angelica, *vis.* the archangelica, a native of Lapland; the sylvestris, a native of Britain; the purpurea, and the lucida, both natives of Canada. All the parts of the archangelica, but particularly the roots, are aromatic, and used in several alexeterial waters.
- ANGELICA**, in Grecian antiquity, a celebrated dance, performed at their feasts, so called, because the dancers were dressed in the habit of messengers.
- ANGELICS**, in church-history, an ancient sect of heretics, supposed by some to have got this appellation from their excessive veneration of angels; and by others, from their maintaining that the world was created by angels.
- ANGELICS** is also the name of an order of knights, instituted in 1101, by Angelus Flavius Comnenus emperor of Constantinople.
- ANGELICS** is also a congregation of nuns, founded at Milan in 1534, by Louisa Torelli, countess of Guastalla. They observe the rule of St Augustine.
- ANGELITES**, in church-history, an ancient sect of heretics, whose distinguishing tenet was, That the Trinity have no distinct substance, but partake in common of the same divine essence.
- ANGELO**, or **ST ANGELO**, a sea-port town of Apulia in Naples, situated on the gulf of Venice, in  $16^{\circ} 25'$  E. long. and  $41^{\circ} 20'$  N. lat. It is also the name of two other small towns in Italy, one situated in the kingdom of Naples, and the other in the province of Urbino.
- ANGELOLATRIA**, among ecclesiastical writers, the adoration or worship of angels.
- ANGELOS**, a fine city of Mexico, situated in  $103^{\circ}$  W. long. and  $19^{\circ}$  N. lat. about 75 miles south-east of the city of Mexico.
- ANGELOT**, a gold coin struck at Paris, while subject to the English; so called from the representation of an angel supporting the arms of England and France.
- ANGELUS**. See **ANGEL**.
- ANGER**, a violent desire to be avenged for some supposed injury. See **MORALS**.
- ANGERBURG**, a city of Prussia, in the province of Bartenland, upon the river Angerap.
- ANGERMANNIA**, a maritime province of Sweden, lying on the western shore of the Bothnic gulph.
- ANGERMUND**, a town of the dutchy of Berg in Germany, situated on the east side of the Rhine, in  $6^{\circ} 20'$  E. long. and  $51^{\circ} 10'$  N. lat. It lies about nine miles north of Dusseldorp, and is subject to the elector Palatine.
- ANGERONALIA**, in antiquity, feasts celebrated at Rome in honour of Angerona, the goddess of silence and patience. They were instituted, according to Macrobius, in consequence of a vow, when the people were afflicted with the quinzy. They were held on the 21st of December.
- ANGERS**, a large city of France, capital of the province of Anjou, and situated on the river Loire, in  $30'$  W. long. and  $47^{\circ} 30'$  N. lat. It is a bishop's see, and has a royal academy for the study of the law chiefly.
- ANGHIERA**, a town of the Milanese in Italy, situated on the east side of the Lago Maggiore, about 40 miles west of Milan, in  $9^{\circ}$  E. long. and  $45^{\circ} 40'$  N. lat.
- ANGINA**, in medicine, a violent inflammation of the throat, otherwise called *quinzy*. See **MEDICINE**.
- ANGIOSPERMIA**, in the Linnzan system of botany, denotes those plants of the didynamia class, which have their seeds inclosed in capsules, or seed-vessels. See **DIDYNAMIA**, and **BOTANY**.
- ANGLE**, in geometry, the inclination of two lines meeting one another in a point, and called the *legs of the angle*. See **GEOMETRY**.
- Spherical ANGLE**, that formed by the intersection of two great circles of the sphere. See **TRIGONOMETRY**.
- ANGLES of the eye**, in anatomy, the same with the corners of the eye, called by anatomists *canthi*.
- ANGLER**, a person who practises the art of angling.
- ANGLESEY**, an island on the coast of N. Wales, which sends one member to parliament.
- ANGLICANUS Sutor**, among physicians. See **SUDOR**.
- ANGLICISM**, in style, a manner of speech peculiar to the English language.
- ANGLING**, among sportsmen, the art of fishing with

- a rod, to which are fitted a line, hook, and bait.— For the several methods of angling for salmon, trout, carp, perch, pearch, flounder, &c. See *SALMON-FISHING*, *TROUT-FISHING*, &c.
- ANGLO-CALVINISTS**, a name given by some writers to the members of the church of England, as agreeing with the other Calvinists in most points, except church-government.
- ANGLO-SAXON**, an appellation given to the language spoken by the English Saxons, in contradistinction from the true Saxon, as well as from the modern English.
- ANGOL**, a city of Chili in S. America, situated in 78° W. long. and 38° S. lat.
- ANGOLA**, a large maritime country on the south-west side of Africa, lying between 10° and 15° E. long. and 5° and 16° S. lat.
- The Portuguese have several colonies and considerable settlements on this coast, which does not hinder the other nations of Europe from driving a traffic in slaves with the natives, who are all negroes.
- ANGOLA-seeds**. See *MOLUCCA*.
- ANGON**, in the ancient military art, a kind of javelin used by the French. They darted it at a considerable distance. The iron head of this weapon resembled a flower-de-luce. It is the opinion of some writers, that the arms of France are not flowers-de-luce, but the iron point of the angon, or javelin of the ancient French.
- ANGONÆUS**, in anatomy, a name sometimes given to the muscle called *anconæus*. See page 197.
- ANGOR**, among ancient physicians, a concentration of the natural heat, the consequence of which is a pain of the head, palpitation, and sadness.
- ANGOULESME**, a city of France, situated about 64 miles south-east of Rochelle, in 16° E. long. and 45° 40' N. lat. It is the capital of Angoumois. See the next article.
- ANGOUMÔIS**, a province of France, bounded by Poitou on the north, by Limosin on the east, by Périgord on the south, and by Santois on the west.
- ANGOURA**, formerly Ancyra, a large populous city of Natolia, in Asiatic Turkey, situated on the river Meles; E. long. 33°. N. lat. 41° 5'.
- ANGRA**, the principal town of the island of Terceira, one of the Azores. See *AZORES*.
- ANGROGNA**, a town of Piedmont; situated about seven miles west of Pignerol; E. long. 7°. N. lat. 44° 45'.
- ANGUIAN**, or *ERGVIEU*, a small town of the Netherlands, between Brussels and Mons.
- ANGUILLA**, in zoology, a synonyme of the nereis acustris, an insect belonging to the order of vermes mollusca. See *NEREIS*. It is also the trivial name of a species of muræna or eel. See *MURÆNA*.
- ANGUILLA**, in geography, one of the Caribbee islands, subject to G. Britain, and situated in W. long. 63°. and N. lat. 18° 15'.
- ANGUILLARA**, a town in the territory of Padua, belonging to the state of Venice.
- ANGUILLARA**, is also a town of St Peter's patrimony, about 18 miles from Rome.
- ANGUILLIFORM**, an appellation given by zoologists, not only to the different species of eels, but to other animals resembling them in shape.
- ANGUINA**, in botany, a synonyme of the trichosanthes. See *TRICHOSANTHES*.
- ANGUINEAL**, denotes something belonging to, or resembling a snake, anguis.
- ANGUINUM ovum**, among ancient naturalists, a fabulous kind of egg, said to be produced by the saliva of a cluster of serpents, and possessed of certain magical virtues.
- ANGUIS**, or *SNAKE*, in zoology, a genus belonging to the order of amphibia serpentes. The characters of the anguis are these: They are squamous or scaly in the belly and under the tail. There are 16 species of the anguis; viz. 1. The quadrupes: The body of this species is cylindrical, with 14 or 15 longitudinal ash-coloured streaks; the teeth are extremely small; it has no ears; the feet are at a great distance from each other, very short, with five toes and small nails; but the toes are so minute that they can hardly be numbered: It is a native of Java. 2. The bipes, is a native of the Indies; it has 100 scuta on the belly, and 60 on the tail; the scuta are succedanea for feet, ranged on both sides; it has two short feet, with two toes, near the anus. In every scale of the bipes there is a brown point. 3. The melagris, is likewise a native of the Indies, and has 165 scuta on the belly, and 32 on the tail: It has small teeth, but no ears. This species has a great resemblance to the former. See Plate XXII. fig. 1. 4. The colabrinæ, is an inhabitant of Egypt, has 180 scuta on the belly, and 18 on the tail; it is beautifully variegated with pale and yellowish colours. 5. The jaculus, a native of Egypt, has 186 scuta on the belly, and 23 on the tail; the scales on the belly are broad. 6. The maculata, a native of America, has 200 scuta on the belly, and 12 on the tail; it is yellow, and interspersed with ash-coloured lines on the back: The head is small in proportion to the body. See Plate XXII. fig. 2. 7. The reticulata, a native of America, has 177 scuta on the belly, and 37 on the tail; the colour of the scales is brownish, with a white margin. 8. The cerastes, with 200 scuta on the belly, and 15 on the tail, is a native of Egypt. 9. The humbricalis, a native of America, has 236 scuta on the belly, and 7 on the tail; its colour is a yellowish white. 10. The ventralis, a native of Carolina, has 127 scuta on the belly, and 222 on the tail. 11. The platyura; the head is oblong and without teeth; the body is about a foot and a half long, black above and white below; the tail is about one ninth of the length of the animal, much compressed or flattened, and variegated with black and white; the scales are roundish, small, not imbricated, but they cannot be numbered. 12. The laticauda, a native of Surinam, has 200 scuta on the belly, and 50 on the tail; the tail is compressed, acute, pale, with brownish belts. 13. The scytale, a native of the Indies, with 220 scuta on the belly, and 13 on the tail. The head is small and oval, and the eyes are little; the body is cylindrical, about a foot and a half long, covered with oval obtuse.

- tuse scales: The tail is thick and obtuse like the head; its colour is white, interspersed with brownish rings; the margins of the scales are of an iron-colour; and the top of the head is blue. See Plate XXII. fig. 3. 14. The eryx, a native of Britain and likewise of America, has 126 scuta on the belly, and 136 on the tail. It is of an ash-colour above, with three black lines interspersed, and blueish below: It is about a span in length, and about the thickness of a man's finger. 15. The fragilis, a native of Europe, has 135 scuta on the belly, and 135 on the tail. 16. The ventralis, a native of Carolina, has 127 scuta on the belly, and 223 on the tail. It is of a greenish ash-colour, and its tail is about thrice as long as its body. According to Linnæus, none of this genus are poisonous.
- ANGULAR**, in a general sense, denotes something relating to, or that hath angles. See **ANGLES**.
- ANGULARIS scapulae**, the name by which some anatomists call the levator scapulae. See **ANATOMY**, page 194.
- ANGURIA**, in botany, a genus of the monoclea dianthia class. There are only three species of the anguria, viz. the trilobata, pedata, and trifoliata, all natives of America.
- ANGUS**, a shire or county of Scotland, bounded on the north by the shire of Merns, on the east by the German ocean, on the south by the frith of Tay, which divides it from the shire of Fife, and on the west by the shire of Perth.
- This county, which for the most part is exceeding fertile, is otherwise called Forfarshire, from its capital Forfar.
- ANGUSTICLAVIA**, in Roman antiquity, a tunica embroidered with little purple studs. It was worn by the Roman knights, as the laticlavia was by the senators.
- ANHALT**, a province of the circle of Upper Saxony, in Germany, lying southward of the duchy of Magdeburg.
- ANHELATIO**, or **ANHELITUS**, among physicians, a shortness of breath.
- ANHINGA**, in ornithology, the trivial name of a species of plotus. See **PLOTUS**.
- ANHYDROS**, in botany, an obsolete name of the solanum. See **SOLANUM**.
- ANI**, in ornithology, the trivial name of a species of crotophaga. See **CROTOPHAGA**.
- ANIAN**, a large maritime country on the eastern coast of Africa, lying between the equator, and 12° N. lat. and between 40° and 50° E. long.
- ANIAN** is also the name of a strait, supposed to lie between the north-east of Asia and north-west of America.
- ANJENGO**, a small town and factory on the Malabar coast, belonging to our East-India company.
- ANIENS**, or **ANIENTE**, a law-term, signifying to be void, or of no force.
- ANIL**, in botany, a synonyme of a species of indigofera. See **INDIGOFERA**.
- ANIMA**, among divines and naturalists, denotes the soul, or principle of life, in animals.
- ANIMA**, among chemists, denotes the volatile or spiritous parts of bodies.
- ANIMA hepatis**, is a name by which some call sal martis, or salt of iron, on account of its supposed efficacy in diseases of the liver.
- ANIMA saturni**, a white powder obtained by pouring distilled vinegar on litharge, of considerable use in enamelling. See **ENAMEL**.
- ANIMA**, or **ANIMATO**, in music, the same with allegro. See **ALLEGRO**.
- ANIMACHA**, a river of India, in the kingdom of Malabar. It rises in the kingdom of Calicut, and falls into the ocean six leagues from Cranganor. It is also the name of a town upon the river.
- ANIMADVERSION**, in matters of literature, is used to signify, sometimes correction, sometimes remarks upon a book, &c. and sometimes a serious consideration upon any point.
- ANIMAL**, in natural history, an organized body endowed with sensation: Thus, minerals are said to grow or increase; plants to grow and live; but animals alone to have sensation. See **NATURAL HISTORY**.
- ANIMALS**, in heraldry, are much used, both as bearings and supporters. See **HERALDRY**.
- ANIMAL**, used adjectively, denotes any thing belonging to, or partaking of the nature of animals. Thus, animal actions, those that are peculiar to animals; such are sensation and muscular motion.
- ANIMAL spirits**. See **NERVOUS fluid**.
- ANIMAL system** denotes the whole class of beings endowed with animal life, otherwise called *animal kingdom*.
- ANIMALCULE**, an animal so minute in its size, as not to be the immediate object of our senses. See **MICROSCOPE**.
- ANIMATED**, or **ANIMATE**, in a general sense, denotes something endowed with animal life. It also imports a thing to be impregnated with vermin or animalcules.
- ANIME**, in heraldry, a term used when the eyes of any rapacious creature are born of a different tincture from the creature itself.
- ANIMETTA**, among ecclesiastical writers, denotes the cloth wherewith the cup of the eucharist is covered.
- ANIMI diliquium**, fainting or swooning.
- ANINGA**, in commerce, a root which grows in the Antilles islands, and is pretty much like the China plant. It is used by sugar-bakers, for refining the sugar; and is more effectual, and less dangerous, than the sublimate of mercury and arsenic.
- ANJOU**, a country, or rather earldom of France, bounded by the province of Maine on the north, by Tourain on the east, by Poictou on the south, and by Britany on the west.
- ANISCALPTOR**, in anatomy, a name by which some call the latissimus dorsi. See page 195.
- ANITERSOR**, in anatomy, another name by which some call the latissimus dorsi.

ANKER.

**ANKER**, a liquid measure at Amsterdam. It contains about 32 gallons English measure.

**ANN**, or **ANNAT**, in Scots law, is half a year's stipend, which the law gives to the executors of ministers of the church of Scotland, over and above what was due to the minister himself, for his incumbency. See **SCOTS LAW**, title, *Ecclesiastical persons*.

**ANNA**, in Roman antiquity, an appellation given to the moon. See the article **MOON**.

**ANNA**, in geography, a city of Arabia Petrea, situated on the western shore of the river Euphrates, in  $41^{\circ} 35'$  of E. long, and  $33^{\circ} 30'$  N. lat.

**ANNAACIOUS**, a people of Brasil, in America, whose country borders on the government of Porto Seguro.

**ANNABERG**, a small town of Germany, in the province of Misnia, situated near the river Schop, about 11 German miles from Leipzig.

**ANNAGH**, the name of two towns in Ireland, one in the province of Ulster, and the other in the county of Downe.

**ANNALE**, in the church of Rome, a term applied to the masses celebrated for the dead during a whole year.

**ANNALS**, in matters of literature, a species of history, which relates events in the chronological order wherein they happened. They differ from perfect history in this, that annals are a bare relation of what happened every year, as a journal is of what passes every day; whereas history relates, not only the transactions themselves, but also the causes, motives, and springs of actions.

**ANNALES**, in law. See **YEARLINGS**.

**ANNAMABOE**, an English factory on the gold coast, in Guinea, in Africa.

**ANNAN**, the capital of the shire of Annandale, in Scotland, situated upon a river of the same name, in  $3^{\circ}$  W. long. and  $54^{\circ} 40'$  N. lat.

**ANNAPOLIS**, the capital of Maryland, a British colony in N. America, in  $78^{\circ}$  W. long. and  $39^{\circ} 25'$  N. lat.

**ANNAPOLIS**, is also the name of the capital of Nova Scotia, situated in  $64^{\circ}$  W. long. and  $45^{\circ}$  N. lat.

**ANNATES**, among ecclesiastical writers, a year's income of a spiritual living.

These were, in ancient times, given to the pope through all Christendom, upon the decease of any bishop, abbot, or parish-clerk, and were paid by his successor. At the reformation they were taken from the pope, and vested in the king; and finally, queen Ann restored them to the church, by appropriating them to the augmentation of poor livings.

**ANNEALING**, or **NEALING**, the burning or baking glass, earthen ware, &c. in an oven or furnace. See **NEALING**.

**ANNE**, or **ST ANNE'S-DAY**, a festival of the Christian church, celebrated by the Latins on the twenty-sixth of July, but by the Greeks on the ninth of December. It is kept in honour of Anne, or Anna, mother of the Virgin Mary.

**ANNECY**, a town of the duchy of Savoy, situated upon a lake of the same name, subject to the king of Sardinia, in  $6^{\circ} 10'$  E. long. and  $46^{\circ}$  N. lat.

**ANNEXATION**, in law, a term used to imply the uniting of lands or rents to the crown.

**ANNI nubiles**, in law, denotes the marriageable age of a woman, viz. after she has arrived at twelve.

**ANNIENTED**, in law, signifies annulled or made void.

**ANNIHILATION**, the act of reducing any created being into nothing.

**ANNIVERSARY**, the annual return of any remarkable day. Anniversary days, in old times more particularly, denoted those days in which an office was performed for the souls of the deceased, or the martyrdom of the saints was celebrated in the church.

**ANNOBON**, an island of Africa, on the coast of Guinea, in  $7^{\circ}$  E. long. and  $1^{\circ} 50'$  S. lat.

**ANNO Domini**, i. e. the year of our Lord, the computation of time from our Saviour's incarnation.

**ANNOISANCE**, in law, the same with nuisance. See **NUSANCE**.

**ANNOMINATION**, in rhetoric, the same with what is otherwise called *paronomasia*. See **PARONOMASIA**.

**ANNONA**, in Roman antiquity, denotes provision for a year of all sorts, as of flesh, wine, &c. but especially of corn. Annona is likewise the allowance of oil, salt, bread, flesh, corn, wine, hay, and straw, which was annually provided by the contractors for the maintenance of an army.

**ANNONÆ præfectus**, in antiquity, an extraordinary magistrate, whose business it was to prevent a scarcity of provision, and to regulate the weight and fineness of bread.

**ANNONAY**, a town of France in the upper Vivares, situated on the river Deame, in  $5^{\circ} 22'$  E. long. and  $45^{\circ} 15'$  N. lat.

**ANNOT**, a small city in the mountains of Provence in France, in  $7^{\circ}$  E. long. and  $44^{\circ} 4'$  N. lat.

**ANNOTATION**, in matters of literature, a brief commentary, or remark upon a book or writing, in order to clear up some passage, or draw some conclusion from it.

**ANNUA pensio**, in law, an old writ for granting an annual pension to one of the king's chaplains.

**ANNUAL**, in a general sense, an appellation given to whatever returns every year, or is always performed within that space of time: Thus we say, The annual motion of the earth, annual plants, &c.

**ANNUALRENT**, in Scots law, an yearly profit due by a debtor in a sum of money to a creditor for the use of it. See **SCOTS LAW**, title, *Obligations arising from consent*.

*Right of ANNUALRENT*, in Scots law, the original method of burdening lands with an yearly payment for the loan of money, before the taking of interest for money was allowed by statute. See **SCOTS LAW**, title, *Heretable and moveable rights*.

**ANNUENTES musculi**, in anatomy, the same with *recti interni minores*. See **ANATOMY**. Part II.

# A N N U I T I E S.

**A**N Annuity is a sum of money, payable yearly, half-yearly, or quarterly, to continue a certain number of years, for ever, or for life.

An annuity is said to be in arrear, when it continues unpaid after it falls due. And an annuity is said to be in reversion, when the purchaser, upon paying the price, does not immediately enter upon possession; the annuity not commencing till some time after.

Interest on annuities may be computed either in the way of simple or compound interest. But compound interest, being found most equitable, both for buyer and seller, the computation by simple interest is universally disused.

### I. Annuities for a certain Time.

**PROBLEM 1.** Annuity, rate, and time, given, to find the amount, or sum of yearly payments, and interest.

**RULE.** Make 1 the first term of a geometrical series, and the amount of 1 l. for a year the common ratio; continue this series to as many terms as there are years in the question; and the sum of this series is the amount of 1 l. annuity for the given years; which, multiplied by the given annuity, will produce the amount sought.

**EXAMPLE.** An annuity of 40 l. payable yearly, is forborn and unpaid till the end of 5 years: What will then be due, reckoning compound interest at 5 per cent. on all the payments then in arrear?

1    2    3    4    5  
1 : 1.05 : 1.1025 : 1.157625 : 1.21550625; whose sum is 5.52563125 l.; and 5.52563125 X 40 = 221.02525 = 221 l. 0 s. 6 d. the amount sought.

The amount may also be found thus: Multiply the given annuity by the amount of 1 l. for a year; to the product add the given annuity, and the sum is the amount in 2 years; which multiply by the amount of 1 l. for a year; to the product add the given annuity, and the sum is the amount in 3 years, &c. The former question wrought in this manner follows.

40 am. in 1 year.	126.1 am. in 3 years.
1.05	1.05
42.00	132.405
40	40
82 am. in 2 years,	172.405 am. in 4 years.
1.05	1.05
86.10	181.02525
40	40

126.1 am. in 3 years.    221.02525 am. in 5 years.

If the given time be years and quarters, find the amount for the whole years, as above; then find the amount of 1 l. for the given quarters; by which multiply the amount for the whole years; and to the product add

such a part of the annuity as the given quarters are of a year.

If the given annuity be payable half-yearly, or quarterly, find the amount of 1 l. for half a year or a quarter; by which find the amount for the several half-years or quarters, in the same manner as the amount for the several years is found above.

**PROB. 2.** Annuity, rate, and time given, to find the present worth, or sum of money that will purchase the annuity.

**RULE.** Find the amount of the given annuity by the former problem; and then, by compound interest, find the present worth of this amount, as a sum due at the end of the given time.

**EXAMPLE.** What is the present worth of an annuity of 40 l. to continue 5 years, discounting at 5 per cent. compound interest?

By the former problem, the amount of the given annuity for 5 years, at 5 per cent. is 221.02525; and by compound interest, the amount of 1 l. for five years, at 5 l. per cent. is 1.2762815625

And, 1.2762815625 X 221.02525000 (173.179 = 173 l. 3 s. 7 d. the present worth sought.

The present worth may also be found thus: By compound interest, find the present worth of each year by itself, and the sum of these is the present worth sought. The former example done in this way follows.

1.2762815625	40.00000000	(31.5410
1.21550625	40.00000000	(32.9080
1.157625	40.00000000	(34.5535
1.1025	40.00000000	(36.2811
1.05	40.00000000	(38.0952

Present worth, 173.1788

If the annuity to be purchased be in reversion, find first the present worth of the annuity, as commencing immediately, by any of the methods taught above; and then, by compound interest, find the present worth of that present worth, rebating for the time in reversion; and this last present worth is the answer.

**EXAMPLE.** What is the present worth of a yearly pension or rent of 75 l. to continue 4 years, but not to commence till 3 years hence, discounting at 5 per cent.?

.05 : 1 :: 75 : 1500  
 1.05 X 1.05 X 1.05 X 1.05 = 1.21550625  
 1.21550625 X 1500.00000 (1234.05371  
 1500  
 1234.05371

265.94629, present worth of the annuity, if it was to commence immediately.

1.05 X 1.05 X 1.05 = 1.157625 L. s. d.  
1.157625 X 265.94629 (229.7344 = 229. 14 8 1/2

**PROB. 3.** Present worth, rate and time given, to find the annuity.

**RULE.**



**RULE.** By the preceding problem, find the present worth of 1 l. annuity for the rate and time given; and then say, As the present worth thus found to 1 l. annuity, so the present worth given to its annuity; that is, divide the given present worth by that of 1 l. annuity.

**EXAMP.** What annuity, to continue 5 years, will purchase, allowing compound interest at 5 per cent.

$$.05 : 1 :: 1 : 20 l.$$

$$1.05 \times 1.05 \times 1.05 \times 1.05 \times 1.05 = 1.2762815625$$

$$1.2762815625 \times 20.000000000 = 25.52563125$$

$$\underline{15.6705}$$

4.3295 present worth of 1 l. annuity.  
4.329) 173.179(40 l. annuity. *Ans.*

### II. Annuities for ever, or freehold Estates.

In freehold estates, commonly called *annuities in fee simple*, the things chiefly to be considered are, 1. The annuity or yearly rent. 2. The price or present worth. 3. The rate of interest. The questions that usually occur on this head will fall under one or other of the following problems.

**PROB. 1.** Annuity and rate of interest given, to find the price.

As the rate of 1 l. to 1 l. so the rent to the price.

**EXAMP.** The yearly rent of a small estate is 40 l.: What is it worth in ready money, computing interest at  $3\frac{1}{2}$  per cent.

*L. s. d.*

As .035 : 1 :: 40 : 1142.857142 = 1142 17 1 $\frac{1}{2}$

**PROB. 2.** Price and rate of interest given, to find the rent or annuity.

As 1 l. to its rate, so the price to the rent.

**EXAMP.** A gentleman purchases an estate for 4000 l. and has  $4\frac{1}{2}$  per cent. for his money: Required the rent.

As 1 : .045 :: 4000 : 180 l. rent sought.

**PROB. 3.** Price and rent given, to find the rate of interest.

As the price to the rent, so 1 to the rate.

**EXAMP.** An estate of 180 l. yearly rent is bought for 4000 l.: What rate of interest has the purchaser for his money?

As 4000 : 180 :: 1 : .045 rate sought.

**PROB. 4.** The rate of interest given, to find how many years purchase an estate is worth.

Divide 1 by the rate, and the quot is the number of years purchase the estate is worth.

**EXAMP.** A gentleman is willing to purchase an estate, provided he can have  $2\frac{1}{2}$  per cent. for his money: How many years purchase may he offer?

.025) 1.000(40 years purchase. *Ans.*

**PROB. 5.** The number of years purchase at which an estate is bought or sold, given, to find the rate of interest.

Divide 1 by the number of years purchase, and the quot is the rate of interest.

**EXAMP.** A gentleman gives 40 years purchase for an estate: What interest has he for his money?

40) 1.000(.025 rate sought.

The computations hitherto are all performed by a single division or multiplication, and it will scarcely be perceived that the operations are conducted by the rules of compound interest; but when a reversion occurs, recourse must be had to tables of annuities on compound interest.

**PROB. 6.** The rate of interest, and the rent of a freehold estate in reversion, given, to find the present worth or value of the reversion.

By Prob. 1. find the price or present worth of the estate, as if possession was to commence presently; and then, by the Tables, find the present value of the given annuity, or rent, for the years prior to the commencement; subtract this value from the former value, and the remainder is the value of the reversion.

**EXAMP.** A has the possession of an estate of 130 l. per annum, to continue 20 years; B has the reversion of the same estate from that time for ever: What is the value of the estate, what the value of the 20 years possession, and what the value of the reversion, reckoning compound interest at 6 per cent.

By Prob. 1. .06) 130.00(2166.6666 value of the estate.

By Tables 1491.0896 val. of the possession.

675.5770 val. of the reversion.

**PROB. 7.** The price or value of a reversion, the time prior to the commencement, and rate of interest, given, to find the annuity or rent.

By the Tables, find the amount of the price of the reversion for the years prior to the commencement; and then, by Prob. 2. find the annuity which that amount will purchase.

**EXAMP.** The reversion of a freehold estate, to commence 20 years hence, is bought for 675.577 l. compound interest being allowed at 6 per cent.: Required the annuity or rent.

By the Tables the amount of 675.577 l. } *L.*  
for 20 years, at 6 per cent. is } 2166.6

By Prob. 2. 2166.6  $\times$  .06 = 130.0 rent sought.

### III. Life Annuities:

The value of annuities for life is determined from observations made on the bills of mortality. Dr Halley, Mr Simpson, and Monf. de Moivre, are gentlemen of distinguished merit in calculations of this kind.

Dr Halley had recourse to the bills of mortality at Breslaw, the capital of Silesia, as a proper standard for the other parts of Europe, being a place pretty central, at a distance from the sea, and not much crowded with traffickers or foreigners. He pitches upon 1000 persons all born in one year, and observes how many of these were alive every year, from their birth to the extinction of the last, and consequently how many died each year, as in the first of the following tables: which is well adapted to Europe in general. But in the city of London, there is observed to be a greater disparity in the births and burials than in any other place, owing probably to the vast resort of people thither, in the way of commerce, from all parts of the known world. Mr Simpson, therefore, in order to have a table particularly

*suited*

Suited to this populous city, pitches upon 1280 persons all born in the same year, and records the number remaining alive each year, till none were in life.

Dr Halley's table on the bills of mortality at Breslaw.

Age.	Perf. liv.	A.	Perf. liv.	A.	Perf. liv.	A.	Perf. liv.
1	1000	24	573	47	377	70	142
2	855	25	567	48	367	71	131
3	798	26	560	49	357	72	120
4	760	27	553	50	346	73	109
5	732	28	546	51	335	74	98
6	710	29	539	52	324	75	88
7	692	30	531	53	313	76	78
8	680	31	523	54	302	77	68
9	670	32	515	55	292	78	58
10	661	33	507	56	282	79	49
11	653	34	499	57	272	80	41
12	646	35	490	58	262	81	34
13	640	36	481	59	252	82	28
14	634	37	472	60	242	83	23
15	628	38	463	61	232	84	20
16	622	39	454	62	222	85	15
17	616	40	445	63	212	86	11
18	610	41	436	64	202	87	8
19	604	42	427	65	192	88	5
20	598	43	417	66	182	89	3
21	592	44	407	67	172	90	1
22	586	45	397	68	162	91	0
23	579	46	387	69	152		

Mr Simpson's table on the bills of mortality at London.

Age.	Perf. liv.	A.	Perf. liv.	A.	Perf. liv.	A.	Perf. liv.
0	1280	24	434	48	220	72	59
1	870	25	426	49	212	73	54
2	700	26	418	50	204	74	49
3	635	27	410	51	196	75	45
4	600	28	402	52	188	76	41
5	580	29	394	53	180	77	38
6	564	30	385	54	172	78	35
7	551	31	376	55	165	79	32
8	541	32	367	56	158	80	29
9	532	33	358	57	151	81	26
10	524	34	349	58	144	82	23
11	517	35	340	59	137	83	20
12	510	36	331	60	130	84	17
13	504	37	322	61	123	85	14
14	498	38	313	62	117	86	12
15	492	39	304	63	111	87	10
16	486	40	294	64	105	88	8
17	480	41	284	65	99	89	6
18	474	42	274	66	93	90	5
19	468	43	264	67	87	91	4
20	462	44	255	68	81	92	3
21	455	45	246	69	75	93	2
22	448	46	237	70	69	94	1
23	441	47	228	71	64	95	0

It may not be improper in this place to observe, that however perfect tables of this sort may be in themselves, and however well adapted to any particular climate, yet the conclusions deduced from them must always be uncertain, being nothing more than probabilities, or conjectures drawn from the usual period of human life. And the practice of buying and selling annuities on lives, by rules founded on such principles, may be justly considered as a sort of lottery or chance-work, in which the parties concerned must often be deceived. But as estimates and computations of this kind are now become fashionable, we shall here give some brief account of such as appear most material.

From the above tables the probability of the continuance or extinction of human life is estimated as follows.

1. The probability that a person of a given age shall live a certain number of years, is measured by the proportion which the number of persons living at the proposed age has to the difference between the said number and the number of persons living at the given age.

Thus, if it be demanded, what chance a person of 40 years has to live seven years longer? from 445, the number of persons living at 40 years of age in Dr Halley's table, subtract 377, the number of persons living at 47 years of age, and the remainder 68, is the number of persons that died during these 7 years; and the probability or chance that the person in the question shall live these 7 years is as 377 to 68, or nearly as 5½ to 1. But, by Mr Simpson's table, the chance is something less than that of 4 to 1.

2. If the year to which a person of a given age has an equal chance of arriving before he dies, be required, it may be found thus: Find half the number of persons living at the given age in the tables, and in the column of age you have the year required.

Thus, if the question be put with respect to a person of 30 years of age, the number of that age in Dr Halley's table is 531, the half whereof is 265, which is found in the table between 57 and 58 years; so that a person of 30 years has an equal chance of living between 27 and 28 years longer.

3. By the tables, the premium of insurance upon lives may in some measure be regulated.

Thus, The chance that a person of 25 years has to live another year, is, by Dr Halley's table, as 80 to 1; but the chance that a person of 50 years has to live a year longer is only 30 to 1. And, consequently, the premium for insuring the former ought to be to the premium for insuring the latter for one year, as 30 to 80, or as 3 to 8.

PROB. I. To find the value of an annuity of 1 l. for the life of a single person of any given age.

MONS. DE MOIRVE, by observing the decrease of the probabilities of life, as exhibited in the table, composed an algebraic theorem or canon, for computing the value of an annuity for life; which canon I shall here lay down by way of

RULES. Find the complement of life; and, by the tables, find the value of 1 l. annuity for the years denoted by the said complement; multiply this value by the amount

amount of 1 l. for a year, and divide the product by the complement of life; then subtract the quot from 1; divide the remainder by the interest of 1 l. for a year; and this last quot will be the value of the annuity sought, or, in other words, the number of years purchase the annuity is worth.

EXAMP. What is the value of an annuity of 1 l. for an age of 50 years, interest at 5 per cent.

86  
50 age given.  
36 complement of life.

By the Tables, the value is, 16.5468

Amount of 1 l. for a year, 1.05  
827340  
165468

Complement of life, 36)17:374140(.482615

From unity, viz. 1.000000

Subtract .482615

Interest of 1 l. .05).517385(10.3477, value sought.

By the preceding problem is constructed the following table.

The value of 1 l. annuity for a single life.

Age.	3 per c.	3½ perc.	4 per c.	4½ perc.	5 per c.	6 per c.
9=10	19.87	18.27	16.88	15.67	14.60	12.80
8=11	19.74	18.16	16.79	15.59	14.53	12.75
7=12	19.60	18.05	16.64	15.51	14.47	12.70
13	19.47	17.94	16.60	15.43	14.41	12.65
6=14	19.33	17.82	16.50	15.35	14.34	12.60
15	19.19	17.71	16.41	15.27	14.27	12.55
16	19.05	17.59	16.31	15.19	14.20	12.50
5=17	18.90	17.46	16.21	15.10	14.12	12.45
18	18.76	17.33	16.10	15.01	14.05	12.40
19	18.61	17.21	15.99	14.92	13.97	12.35
4=20	18.46	17.09	15.89	14.83	13.89	12.30
21	18.30	16.96	15.78	14.73	13.81	12.20
22	18.15	16.83	15.67	14.64	13.72	12.15
23	17.99	16.69	15.55	14.54	13.64	12.10
3=24	17.83	16.56	15.43	14.44	13.55	12.00
25	17.66	16.42	15.31	14.34	13.46	11.95
26	17.50	16.28	15.19	14.23	13.37	11.90
27	17.33	16.13	15.04	14.12	13.28	11.80
28	17.16	15.98	14.94	14.02	13.18	11.75
29	16.98	15.83	14.81	13.90	13.09	11.65
30	16.80	15.68	14.68	13.79	12.99	11.60
2=31	16.62	15.53	14.54	13.67	12.88	11.50
32	16.44	15.37	14.41	13.55	12.78	11.40
33	16.25	15.21	14.27	13.43	12.67	11.35
34	16.06	15.05	14.12	13.30	12.56	11.25
35	15.86	14.89	13.98	13.17	12.45	11.15
36	15.67	14.71	13.82	13.04	12.33	11.05
37	15.46	14.52	13.67	12.90	12.21	11.00
38	15.29	14.34	13.52	12.77	12.09	10.90
1=39	15.05	14.16	13.36	12.63	11.96	10.80
40	14.84	13.98	13.20	12.48	11.83	10.70

The value of 1 l. annuity for a single life.

A.	3 per c.	3½ perc.	4 per c.	4½ perc.	5 per c.	6 per c.
41	14.63	13.79	13.02	12.33	11.70	10.55
42	14.41	13.59	12.85	12.18	11.57	10.45
43	14.19	13.40	12.68	12.02	11.43	10.35
44	13.96	13.20	12.50	11.87	11.29	10.25
45	13.73	12.99	12.32	11.70	11.14	10.10
46	13.49	12.78	12.13	11.54	10.99	10.00
47	13.25	12.56	11.94	11.37	10.84	9.85
48	13.01	12.36	11.74	11.19	10.68	9.75
49	12.76	12.14	11.54	11.00	10.51	9.60
50	12.51	11.92	11.34	10.82	10.35	9.45
51	12.26	11.69	11.13	10.64	10.17	9.30
52	12.00	11.45	10.92	10.44	9.99	9.20
53	11.73	11.20	10.70	10.24	9.82	9.00
54	11.46	10.95	10.47	10.04	9.63	8.85
55	11.18	10.69	10.24	9.82	9.44	8.70
56	10.90	10.44	10.01	9.61	9.24	8.55
57	10.61	10.18	9.77	9.39	9.04	8.35
58	10.32	9.91	9.52	9.16	8.83	8.20
59	10.03	9.64	9.27	8.93	8.61	8.00
60	9.73	9.36	9.01	8.69	8.39	7.80
61	9.42	9.08	8.75	8.44	8.16	7.60
62	9.11	8.79	8.48	8.19	7.93	7.40
63	8.79	8.49	8.20	7.94	7.68	7.20
64	8.46	8.19	7.92	7.67	7.43	6.95
65	8.13	7.88	7.63	7.39	7.18	6.75
66	7.79	7.56	7.33	7.12	6.91	6.50
67	7.45	7.24	7.02	6.83	6.64	6.25
68	7.10	6.91	6.75	6.54	6.36	6.00
69	6.75	6.57	6.39	6.23	6.07	5.75
70	6.38	6.22	6.06	5.92	5.77	5.50
71	6.01	5.87	5.72	5.59	5.47	5.20
72	5.63	5.51	5.38	5.26	5.15	4.90
73	5.25	5.14	4.02	4.92	4.82	4.60
74	4.85	4.77	4.66	4.57	4.49	4.30
75	4.45	4.38	4.29	4.22	4.14	4.00
76	4.05	3.98	3.91	3.84	3.78	3.65
77	3.63	3.57	3.52	3.47	3.41	3.30
78	3.21	3.16	3.11	3.07	3.03	2.95
79	2.78	2.74	2.70	2.67	2.64	2.55
80	2.34	2.31	2.28	2.26	2.23	2.15

The above table shews the value of an annuity of one pound for a single life, at all the current rates of interest; and is esteemed the best table of this kind extant, and preferable to any other of a different construction. But yet those who sell annuities have generally one and a half or two years more value, than specified in the table, from purchasers whose age is 20 years or upwards. Annuities of this sort are commonly bought or sold at so many years purchase; and the value assigned in the table may be so reckoned. Thus the value of an annuity

of one pound for an age of 50 years, at 3 per cent. interest, is 12.51; that is, 12 l. 10 s. or twelve and a half years purchase. The marginal figures on the left of the column of age serve to shorten the table, and signify, that the value of an annuity for the age denoted by them, is the same with the value of an annuity for the age denoted by the numbers before which they stand. Thus the value of an annuity for the age of 9 and 10 years is the same; and the value of an annuity for the age of 6 and 14, for the age of 3 and 24, &c. is the same. The further use of the table will appear in the questions and problems following.

QUEST. 1. A person of 50 years would purchase an annuity for life of 200 l.: What ready money ought he to pay, reckoning interest at 4½ per cent.?

By the table the value of 1 l. is 10.8  
Multiply by 200

Value to be paid in ready money 2164.00 *Ans.*

QUEST. 2.—A young merchant marries a widow lady of 40 years of age, with a jointure of 300 l. a-year, and wants to dispose of the jointure for ready money: What sum ought he to receive, reckoning interest at 3½ per cent.?

L.  
By the table the value of 1 l. is 13.98.  
300

Value to be received in ready money 4194.00 *Ans.*

PROB. 2. To find the value of an annuity for the joint continuance of two lives, one life failing, the annuity to cease.

Here there are two cases, according as the ages of the two persons are equal or unequal.

1. If the two persons be of the same age, work by the following

RULE. Take the value of any one of the lives from the table, multiply this value by the interest of 1 l. for a year, subtract the product from 2, divide the foresaid value by the remainder, and the quot will be the value of 1 l. annuity, or the number of years purchase sought.

EXAMP. What is the value of 100 l. annuity for the joint lives of two persons, of the age of 30 years each, reckoning interest at 4 per cent.?

By the table, one life of 30 years is 14.68  
Multiply by .04 .04  
Subtract the product 5872  
From 2.0000  
Remains 1.4128

And 1.4128)14.68(10.39 value of 1 l. annuity.

And 10.39 × 100 = 1039 the value sought.

2. If the two persons are of different ages, work as directed in the following

RULE. Take the values of the two lives from the table, multiply them into one another, calling the result the first product; then multiply the said first product by the interest of 1 l. for a year, calling the result the second product; add the values of the two lives, and from their sum subtract the second product; divide the first

product by the remainder, and the quot will be the value of 1 l. annuity, or the number of years purchase sought.

EXAMP. What is the value of 70 l. annuity for the joint lives of two persons, whereof one is 40 and the other 50 years of age, reckoning interest at 5 per cent.?

By the table the value of 40 years is, 11.83  
And the value of 50 years is, 10.33

First product, 122.4405  
Multiply by .05 .05  
Second product, 6:122025

Sum of the two lives, 22.18000  
Second product deduct, 6.122025

Remainder, 16.057975  
And 16.057975)122.4405(7.62 value of 1 l. annuity.  
70

533.40 value sought.

PROB. 3. To find the value of an annuity upon the longest of two lives; that is, to continue so long as either of the persons is in life.

RULE. From the sum of the values of the single lives, subtract the value of the joint lives, and the remainder will be the value sought.

EXAMP. What is the value of an annuity of 1 l. upon the longest of two lives, the one person being 30, and the other 40 years of age, interest at 4 per cent.?

By the table, 30 years is, 14.68  
40 years is, 13.20

Value of their joint lives, by Prob. 2. } 27.88  
Case 2. is, } 9.62

Value sought, 18.26

If the annuity be any other than 1 l. multiply the answer found as above by the given annuity.

If the two persons be of equal age, find the value of their joint lives by Case 1. of Prob. 2.

PROB. 4. To find the value of the next presentation to a living.

RULE. From the value of the successor's life, subtract the joint value of his and the incumbent's life, and the remainder will be the value of 1 l. annuity; which multiplied by the yearly income, will give the sum to be paid for the next presentation.

EXAMP. A enjoys a living of 100 l. per annum, and B would purchase the said living for his life after A's death: The question is, What he ought to pay for it, reckoning interest at 5 per cent. A being 60, and B 25 years of age?

L.  
By the table, B's life is, 13.46  
Joint value of both lives, by Prob. 2. is, 6.97

The value of 1 l. annuity, 6.49  
Multiply by 100

Value of next presentation, 649.00  
The

The value of a direct presentation is the same as that of any other annuity for life, and is found for 1 l. by the table: which being multiplied by the yearly income, gives the value sought.

PROB. 5. To find the value of a reversion for ever, after two successive lives; or to find the value of a living after the death of the present incumbent and his successor.

RULE. By Prob. 3. find the value of the longest of the two lives, and subtract that value from the value of the perpetuity, and the remainder will be the value sought.

EXAMP. A, aged 50, enjoys an estate or living of 100 l. per annum; B, aged 30, is intitled to his lifetime of the same estate after A's death; and it is proposed to sell the estate just now with the burden of A and B's lives on it: What is the reversion worth, reckoning interest at 4 per cent.?

	<i>L.</i>	
By the table, A's life of 50 is,	11.34	
B's life of 30 is,	14.68	
	26.02	Sum,
Value of their joint lives, found by	8.60	}
Prob. 2. Case 2. is,	17.42	sub.
Value of the longest life,	25.00	
From the value of the perpetuity,	7.58	
Remains the value of 1 l. reversion,	100	
Multiply by	758.00	
Value of the reversion,		

PROB. 6. To find the value of the joint continuance of three lives, one life failing, the annuity to cease.

RULE. Find the single values of the three lives from the table; multiply these single values continually, calling the result the product of the three lives; multiply that product by the interest of 1 l. and that product again by 2, calling the result the double product; then, from the sum of the several products of the lives, taken two and two, subtract the double product; divide the product of the three lives by the remainder, and the quot will be the value of the three joint lives.

EXAMP. A is 18 years of age, B 34, and C 56: What is the value of their joint lives, reckoning interest at 4 per cent.?

By the table, the value of A's life is 16.1, of B's 14.12, and of C's 10.01.

$16.1 \times 14.12 \times 10.01 = 2275.6$ , product of the 3 lives.

.04  
91.024  
2

182.048, double product.

Product of A and B,  $16.1 \times 14.12 = 227.33$   
A and C,  $16.1 \times 10.01 = 161.16$   
B and C,  $14.12 \times 10.01 = 141.34$

Sum of all, two and two, - - - 529.83  
Double product subtract - - - 182.048

Remainder - - - 347.782

And  $347.782 \div 2275.600 = 6.54$  value sought.

PROB. 7. To find the value of an annuity upon the longest of three lives.

RULE. From the sum of the values of the three single lives taken from the table, subtract the sum of all the joint lives, taken two and two, as found by Prob. 2. and to the remainder add the value of the three joint lives, as found by Prob. 6. and that sum will be the value of the longest life sought.

EXAMP. A is 18 years of age, B 34, and C 56: What is the value of the longest of these three lives, interest at 4 per cent.?

By the table, the single value of A's life is, 16.1  
single value of B's life is, 14.12  
single value of C's life is, 10.01

Sum of the single values, 40.23

By Prob. 2. the joint value of A and B is, 10.76  
joint value of A and C is, 8.19  
joint value of B and C is, 7.65  
Sum of the joint lives, 26.60

Remainder, - - - 13.63

By Prob. 6. the value of the 3 joint lives is, 6.54  
Value of the longest of the 3 lives, - 20.17

Other problems might be added, but these adduced are sufficient for most purposes. The reader probably may wish that the reason of the rules, which, it must be owned, are intricate, had been assigned; but this could not be done without entering deeper into the subject than was practicable in this place. See CHANCES.

A N N

**ANNUITY** of *tiends*, in Scots law, a certain proportion of the tiends of erected benefices formerly payable to the crown, but now gone into disuse.

**ANNULAR**, in a general sense, something in the form of, or resembling a ring. It is also a peculiar denomination for the fourth finger, commonly called the *ring-finger*.

**ANNULATA**, in zoology, an obsolete name of a species of coluber. See COLUBER.

**ANNULET**, in architecture, a small square member in the Doric capital, under the quarter-round.

A N N

Annulet is also a narrow flat moulding, which is common to divers places of the columns, as in the bases, capitals, &c. It is the same member which Vitruvius calls a *fillet*; Palladio, a *listel* or *cincture*; Scamozzi, and Mr Brown, a *supercilium*, *list*, *tinea*, *eye-brow*, *square*, and *rabbit*. See ARCHITECTURE.

**ANNULET**, in heraldry, a mark of distinction which the fifth brother of a family ought to bear to his coat of arms.

The hieroglyphic of the annulet is very various: Some

Some of the ancients used it to denote servitude; the Romans represented by it liberty and nobility. It is an emblem of secrecy, if it have a seal; and of love, if the cypher, the face, or the arms of the person beloved are engraved upon it.

**ANNULLING**, a term sometimes used for cancelling, or making void, a deed, sentence, or the like.

**ANNUNCIADA, ANNUNTIADA, or ANNUNTIATA**, an order of knighthood in Savoy, first instituted by Amadeus I. in the year 1409; their collar was of 15 links, interwoven one with another, in form of a true lover's knot, and the motto, F. E. R. T. signifying, *Fortitudo ejus Rhodum tenuit*. Amadeus VIII. gave the name *Annunciada* to this order, which was formerly known by that of *the knot of love*, changing at the same time the image of St Maurice patron of Savoy, which hung at the collar, for that of the Virgin Mary, and, instead of the motto above-mentioned, substituting the words of the angel's salutation.

**ANNUNCIADA** is also the title of several religious orders, instituted at different times, and at different places, in honour of the annunciation. See the next article.

**ANNUNCIATION**, the tidings brought by the angel Gabriel to the Virgin Mary of the incarnation of Christ.

Annunciation is also a festival, kept by the church on the 25th of March, in commemoration of these tidings.

In the Romish church, on this feast, the pope performs the ceremony of marrying or cloistering a certain number of maidens, who are presented to him in the church, clothed in white serge, and muffled up from head to foot: An officer stands by, with purses containing notes of fifty crowns for those who make choice of marriage, and notes of a hundred for those who chuse the veil.

Annunciation is likewise a title given by the Jews to part of the ceremony of the passover.

**ANNUNTIATOR**, the name of an officer in the church of Constantinople. It was his business to inform the people of the festivals that were to be celebrated.

**ANOCTORON**, a term used by some ecclesiastical writers for a church. See **CHURCH**.

**ANOCISTI**, in zoology, an obsolete name of the echinus. See **ECHINUS**.

**ANODYNE**, in pharmacy, a term applied to medicines which mitigate pain.

Among anodynes may be reckoned all relaxing remedies, diluters, and medicines which by any means destroy acrimony, or expel wind, together with the compound medicines of the shops, which pass under this name; such as the anodyne balsam made of Castile soap, opium, camphire, saffron, and spirit of wine.

**ANOLYMPIADS**, in Grecian antiquity, an appellation given by the Elæans to such Olympic games as had been celebrated under the direction of other states besides themselves. See **OLYMPIAD**.

**ANOMOLISTICAL Year**, in astronomy, the time that the earth takes to pass through her orbit: it is also called the periodical year.

The space of time belonging to this year is greater

than the tropical year, on account of the precession of the equinoxes. See **PRECESSION**, and **ASTRONOMY**.

**ANOMALOUS**, a term applied to whatever is irregular, or deviates from the rule observed by other things of the like nature.

**ANOMALY**, in astronomy, an irregularity in the motion of the planets, whereby they deviate from the aphelion or apogee.

**ANOMIA**, in zoology, a genus of shell-insects belonging to the order of vermes testacea. The ligula is emarginated, and the cilia are fixed to the superior valve; it has two lineal brachii longer than the body: The valves of the shell are equal. There are 25 species of the anomia; such of them whose history is known, are all natives of the European seas.

**ANOMOEANS**, in church-history, ancient heretics, who asserted that the Son was of a nature different, and in nothing like to that of the Father.

**ANOMORHOMBOÏDIA**, in natural history, a genus of crystalline spars, of no determinate form, easily fissile, but cleaving more readily in an horizontal than in a perpendicular direction, their plates being composed of irregular arrangements of short and thick rhomboidal concretions. See **SPAR**.

**ANONA**, in botany, a genus of the polyandria polygynia class. The calix is three-leaved; the petals are six; the fruit is a roundish berry containing many seeds. There are 8 species of the anona, viz. the muricata, squamosa, reticulata, palustris, glabra, triloba, Asiatica, and Africana. All of them natives of the Indies.

**ANONIS**, in botany. See **ONONIS**.

**ANONYMOS**, in botany, a synonyme of a species of spermacoe and several other plants. See **SPERMACOE**.

**ANONYMOUS**, something that is nameless, or of which the name is concealed.

**ANONYMOUS**, in chemistry. See **ADIAPHOROUS**.

**ANOREXY**, in medicine, a loathing of meat, or want of appetite.

**ANOT**. See **ANNOT**.

**ANOTH**, one of the Scilly islands. See **SCILLY**.

**ANOUT**, a small island in the Schagerrack, or that part of the sea of Denmark which has Norway on the north, Jutland on the west, and the isle of Zealand on the south; it lies in 13° E. long. and 56° 36' N. lat.

**ANSA**, a river in Friuli in Italy, which discharges itself into the gulf of Venice.

**ANSÆ**, in astronomy, the parts of Saturn's ring, which are to be seen on each side of that planet, when viewed through a telescope. See **ASTRONOMY**.

**ANSE**, a small town of France in the Lyonnaise, four leagues north of Lyons.

**ANSEL-WEIGHT**, the same with auncel-weight. See **AUNCEL**.

**ANSELM'S Art**, or **ST ANSELM'S Art**. See **ART**.

**ANSER**, in ornithology, the trivial name of a species of ans. See **ANS**.

**ANSERES**, the name which Linnæus gives to his third order of birds. This order is distinguished by the following marks: The beak is covered with a smooth skin

**fin** or membrane, widest at the apex, and full of small holes like a sieve; the toes of the feet are connected by a membrane which enables them to swim; the tibia, or shin-bone, is short and flat. They live upon water-plants, fishes, &c. This order includes 12 genera, viz. the anas, mergus, phaeton, plotus, rhyncops, dromeda, alca, procellaria, pelecanus, larus, sterna, and columbus. See these articles, and NATURAL HISTORY.

**ANSER**, in astronomy, a star of the fifth or sixth magnitude, in the milky-way, between the swan and eagle.

**ANSES**, in astronomy, the same with ansæ. See ANSÆ.

**ANSIANACTES**, a people of Africa, in the western part of the isle of Madagascar.

**ANSLO**, a sea-port town of Norway, and province of Aggerhuys, situated in  $10^{\circ} 12'$  E. long. and  $59^{\circ} 30'$  N. lat.

**ANSPACH**, or **OHNSPACH**, a city of Germany, and circle of Franconia, situated in  $10^{\circ} 36'$  E. long. and  $49^{\circ} 22'$  N. lat.

It is the capital of the marquise of Anspach, of which family was the late queen Caroline.

**ANSPESSADES**, in the French armies, a kind of inferior officer in the foot, below the corporals, but above the common centinels. There are usually four or five of them in a company.

**ANSTRUTHER** *Easter* and *Wester*, two royal burghs of Scotland, situated on the south-east coast of the county of Fife, in  $2^{\circ} 25'$  W. long. and  $56^{\circ} 26'$  N. lat.

**ANT**, in zoology. See FORMICA.

**ANTA**, in the ancient architecture, a square pilaster, placed at the corners of buildings.

**ANTA**, in geography, a little city with a harbour, on the coast of Guinea in Africa.

**ANTACHATES**, in natural history, a bituminous stone, which yields a smell like myrrh, in burning.

**ANTACIDS**, in pharmacy, an appellation given to all medicines proper to correct acid or four humours: Such are the absorbent and obtundent classes, &c.

**ANTAGONIST**, denotes an adversary, especially in speaking of combats and games.

**ANTAGONIST muscles**, in anatomy, those which have opposite functions, as flexors and extensors, abductors and adductors, &c.

**ANTALIS**, in zoology, the trivial name of a species of the dentalium. See DENTALIUM.

**ANTALGICS**, in medicine, the same with anodynes. See ANODYNE.

**ANTANACLASIS**, in rhetoric, a figure which repeats the same word, but in a different sense; as, *dum vivimus, vivamus*.

**ANTANAGOGE**, in rhetoric, a figure by which, when the accusation of the adversary is unanswerable, we load him with the same or other crimes.

**ANTANISOPHYLLUM**, in botany, a synonyme of a species of Boerhaavia. See BOERHAAVIA.

**ANTAPHRODISIACS**, in pharmacy, medicines proper to diminish the semen, and consequently extinguish or lessen all desires of venery.

**ANTARCTIC**, in a general sense, denotes something

opposite to the arctic or northern pole. Hence, antarctic circle is one of the lesser circles of the sphere, and distant only  $23^{\circ} 30'$  from the south pole, which is likewise called antarctic for the same reason.

**ANTARES**, a star of the first magnitude, otherwise called the *scorpion's heart*. See SCORPION.

**ANTE**, in heraldry, denotes that the pieces are let into one another in such form as is there expressed; as, for instance, by dove-tails, rounds, swallow-tails, or the like.

**ANTEAMBULONES**, in Roman antiquity, servants who went before persons of distinction to clear the way before them. They used this formula, *Date locum domino meo*, i. e. Make room, or way, for my master.

**ANTECEDENT**, in general, something that goes before another, either in order of time or place.

**ANTECEDENT**, in grammar, the word to which a relative refers.

**ANTECEDENT**, in logic, is the first of the two propositions in an enthymema.

**ANTECEDENT**, in mathematics, is the first of two terms of a ratio, or that which is compared with the other.

**ANTECEDENT signs**, in medicine, such as are observed before a distemper is so formed as to be reducible to any particular class.

**ANTECEDENCE**, in astronomy, an apparent motion of a planet towards the west, or contrary to the order of the signs.

**ANTECESSOR**, one that goes before. It was an appellation given to those who excelled in any science: Justinian applied it particularly to professors of civil law; and, in the universities of France, the teachers of law take the title *antecessores* in all their theses.

**ANTECURSORES**, in the Roman armies, a party of horse detached before, partly to get intelligence, provisions, &c. and partly to chuse a proper place to encamp in. These were otherwise called *antecessores*, and by the Greeks *prodromi*.

**ANTEDATE**, among lawyers, a spurious or false date, prior to the true date of a bond, bill, or the like.

**ANTEDILUVIAN**, whatever existed before Noah's flood: Thus, the generations from Adam to Noah are called the *antediluvians*. See DELUGE.

**ANTEGO**, one of the Caribbee islands, in the Atlantic or American ocean, situated in  $62^{\circ}$  W. long. and  $17^{\circ} 30'$  N. lat. It is about 20 miles long, and as many broad.

**ANTEJURAMENTUM**, by our ancestors called *juramentum calumnie*, an oath which anciently both accuser and accused were to take before any trial or purgation.

The accuser was to swear that he would prosecute the criminal; and the accused to make oath, on the day he was to undergo the ordeal, that he was innocent of the crime charged against him.

**ANTELOPE**, in zoology. See CAPRA.

**ANTEMURALE**, in the ancient military art, denotes much the same with what the moderns call an *outward*.

**ANTENCLEMA**, in rhetoric, called by the Latins *relatio*, is when the fault is imputed, upon any misfortune happening, to the person to whom it happened.

**ANTENNÆ**, in the history of insects, slender bodies with which nature has furnished the heads of these creatures, being the same with what in English are called *horns* or *feelers*.

**ANTEPAGMENTA**, in the ancient architecture, the jambs of a door. They are also ornaments, or garnishings, in carved work, of men, animals, &c. made either of wood or stone, and set on the architrave.

**ANTEPENULTIMA**, in grammar, the third syllable of a word from the end, or the last syllable but two.

**ANTEPILANI**, in the Roman armies, a name given to the hastati and principes, because they marched next before the triarii, who were called *pilani*.

**ANTEPILEPTICS**, among physicians, medicines esteemed good in the epilepsy.

**ANTEPOSITION**, in grammar, the placing a word first which should stand last.

**ANTEPREDICAMENTS**, among logicians, certain preliminary questions which illustrate the doctrine of predicaments and categories.

**ANTEQUIERA**, a town of Granada, in Spain; situated in W. long.  $4^{\circ} 40'$ , and N. lat.  $36^{\circ} 40'$ ; about 25 miles north of Malaga.

**ANTEQUIRA-NOVA**, an episcopal city of New Spain, in America, in the province of Guaxaca.

**ANTERIDES**, in the ancient architecture, buttresses erected to support a wall. See **BUTRESS**.

**ANTERIOR**, denotes something placed before another, either with respect to time or place.

**ANTEROTES**, in natural history, a name given by the ancients to a species of amethyst. See **AMETHYST**.

**ANTESIGNANI**, in the Roman armies, soldiery placed before the standards, in order to defend them, according to Lælius; but Cæsar and Livy mention the *antesignani* as the first line, or first body, of heavy-armed troops. The velites, who used to skirmish before the army, were likewise called *antesignani*.

**ANTESTATURE**, in fortification, a small retrenchment made of palisadoes, or sacks of earth, with a view to dispute with an enemy the remainder of a piece of ground.

**ANTEVIRGILIAN husbandry**, an appellation given to Mr Tull's new method of horse-hoeing husbandry. See **AGRICULTURE**, Part II.

**ANTHAKIA**, in geography, the same with Antioch. See **ANTIOCH**.

**ANTHELIX**, in anatomy, the inward protuberance of the external ear, being a semicircle within, and almost parallel to the helix. See p. 295.

**ANTHELMINTICS**, among physicians, medicines proper to destroy worms. See **PHARMACY**.

**ANTHEM**, a church-song, performed in cathedral service by choristers who sung alternately.

**ANTHEMIS**, or **CAMOMILE**, in botany, a genus of the syngenesia polygamia superflua class. The receptacle of the anthemis is paleaceous; it has no pappus; the calix is globular. There are 18 species of anthemis, only five of which are natives of Britain, viz.

the nobilis, or sweet-scented camomile; the cotula, or stinking May-weed; the arvensis, or corn-camomile; the maritima, or sea-camomile; and the tinctoria, or common ox-eye. The flowers of the anthemis nobilis are carminative, emollient, and aperient.

**ANTHERÆ**, among botanists, the little roundish or oblong bodies on the tops of the stamina of plants. See **STAMINA**, and **BOTANY**.

**ANTHERICUM**, in botany, a genus of the hexandria monogynia class. The corolla has six petals open at the top; and the capsule is ovate. There are 13 species of anthericum, none of which are natives of Britain, except the calyculatum, or Scottish asphodel.

**ANTHESPORIA**, in antiquity, a Sicilian festival, instituted in honour of Proserpine.

**ANTHESTERIA**, in Grecian antiquity, festivals celebrated in the spring, by the ancient Athenians, in honour of Bacchus, during which the masters feasted their slaves, as the Romans did in the time of the Saturnalia.

**ANTHETERION**, in ancient chronology, the sixth month of the Athenian year, answering to the latter part of our November and beginning of December.

**ANTHLAS**, in ichthyology, the trivial name of a species of labrus. See **LABRUS**.

**ANTHINE wine**, among the ancients, a kind of wine medicated with the flowers of plants.

**ANTHOCEROS**, in botany, a genus of the cryptogamia class. The calix of the male is sessile, cylindrical, and intire; the antheræ are very long, subulate, and two-valved; the calix of the female is divided into six pieces; the seeds are three. There are only three species of the anthoceros, viz. the punctatus, or spotted anthoceros, a native of Britain; the lævis, a native of Europe and America; and the multifidus, a native of Germany.

**ANTHOLOGION**, the title of the service-book used in the Greek church.

It is divided into twelve months, containing the offices sung throughout the year, on the festivals of our Saviour, the Virgin, and other remarkable saints.

**ANTHOLOGY**, a discourse of flowers, or of beautiful passages from any authors.

**ANTHOLOGY** is also the name given to a collection of epigrams taken from several Greek poets.

**ANTHOLYZA**, a genus of the triandria monogynia class. The calix is tubular, irregular, and bent back; the capsule is below the flower. There are four species of the antholyza, viz. the ringens, a native of Æthiopia; the cunonia, a native of Persia; the æthiopia, a native of Æthiopia; and the meriana, a native of the Cape of Good-Hope.

**ANTHONY**, or *Knights of St ANTHONY*, a military order, instituted by Albert duke of Bavaria, Holland, and Zealand, when he designed to make war against the Turks in 1382. The knights wore a collar of gold, made in form of a hermit's girdle, from which hung a stick cut like a crutch, with a little bell, as they are represented in Anthony's pictures.

*St ANTHONY'S fire*, a name sometimes given to the erysipelas. See **ERYSIPELAS**.

**ANTHORA**,



**ANTHORA**, in botany, the trivial name of a species of aconitum. See **ACONITUM**.

**ANTHORISMUS**, in rhetoric, denotes a contrary description or definition of a thing from that given by the adverse party.

**ANTHOS**, a Greek term, properly signifying a flower, but used by some writers to denote rosemary by way of eminence.

**ANTHOS** is sometimes also used for the elixir of gold, as well as for a medicine extracted from pearls.

**ANTHOS philosophorum**, denotes a certain method of transmuting metals by vitriol.

**ANTHOSATUM acetum**, the vinegar of rosemary flowers.

**ANTHOSPERMUM**, in botany, a genus of the polygamia diœcia class. The calix of the hermaphrodite flower is divided into four parts; it has no corolla; the stamina are four, and the pistilli two; the germen is below the flower. There are two species of anthospermum, viz. the æthiopicum, a native of Æthiopia; and the ciliare, a native of the Cape of Good-Hope.

**ANTHOXANTHUM**, in botany, a genus of the dianthia digynia class. The calix is a bivalved gluma, with one flower; the corolla is bivalved, obtuse, and without any awn. There are three species of anthoxanthum, viz. the odoratum, or spring-grass, a native of Britain; the indicum, a native of India; and the paniculatum, a native of the southern parts of Europe.

**ANTHRACIS**, **ANTHRACIAS**, or **ANTHRACITIS**, names promiscuously used by ancient naturalists for very different fossils, viz. the carbuncle, hæmatites, and a kind of asteria. See **CARBUNCLE**, &c.

**ANTHRACOSIS**, in medicine, a corrosive scaly ulcer, either in the bulb of the eye or the eye-lids.

**ANTHRAX**, a Greek term, literally signifying a burning coal, used by the ancients to denote a gem, as well as a disease, more generally known by the name of carbuncle. See **CARBUNCLE**.

**ANTHRAX** is sometimes also used for lithanthrax, or pit-coal. See **LITHANTHRAX**.

**ANTHRISCUS**, in botany, the trivial name of a species of tordylium. See **TORDYLIUM**.

**ANTHROPOGLOTTUS**, among zoologists, an appellation given to such animals as have tongues resembling that of mankind, particularly to the parrot kind.

**ANTHROPOGRAPHY**, denotes the description of the human body, its parts, structure, &c. See **ANATOMY**.

**ANTHROPOLATRÆ**, in church-history, an appellation given to the Nestorians, on account of their worshipping Christ, notwithstanding that they believed him to be a mere man.

**ANTHROPOLATRIA**, the paying divine honours to a man, supposed to be the most ancient kind of idolatry.

**ANTHROPOLOGY**, a discourse upon human nature.

**ANTHROPOLOGY**, among divines, denotes that manner of expression by which the inspired writers attribute human parts and passions to God.

**ANTHROPOMANCY**, a species of divination, per-

formed by inspecting the intrails of a human creature.

**ANTHROPOMORPHA**, a term formerly given to the primates, or that class of animals which have the greatest resemblance to the human kind. See **NATURAL HISTORY**.

**ANTHROPOMORHISM**, among ecclesiastical writers, denotes the heresy or error of the Anthropomorphites. See the next article.

**ANTHROPOMORPHITES**, in church-history, a sect of ancient heretics, who, taking every thing spoken of God in scripture in a literal sense, particularly that passage of Genesis in which it is said *God made man after his own image*, maintained, That God had a human shape. They are likewise called *Audeans*, from Audeus their leader.

**ANTHROPOMORPHOUS**, an appellation given to whatever resembles the human form.

**ANTHROPOPATHY**, a figure or expression by which some passion is ascribed to God, which properly belongs only to man.

**ANTHROPOSCOPY**, that part of physiognomy which judges of a man's character, &c. from the lineaments of his body.

**ANTHROPOPHAGY**, the act of eating human flesh. This horrid practice is said to prevail in some parts of Africa and America. But it is greatly to be doubted if ever such a custom existed.

**ANTHROPTHYSIA**, the inhuman practice of offering human sacrifices. See **SACRIFICE**.

**ANTHUM**, in botany. See **EPITHYMUM**.

**ANTHUS**, in ornithology, a synonyme of the louse. See **LOSEIA**.

**ANTHYLLUS**, in botany, a genus of the diadelphia decandria class. The calix is ventricose, and the legumen is roundish. There are 10 species of anthyllus, viz. the tetraphylla, montana, cornicina, lotoides, barba jovis, heterophylla, cytisoides, hermanice, and erinacea, all natives of Spain, Italy, and the southern parts of Europe; and the vulneraria, kidney-vetch, or lady's finger, a native of Britain.

**ANTHYPOPHORA**, in rhetoric, a figure of speech; being the counter-part of an hypophora. See **HYPOPHORA**.

**ANTI**, a Greek preposition, which enters into the composition of several words, both Latin, French, and English, in different senses. Sometimes it signifies *before*, as in anti-chamber; and sometimes *opposite* or *contrary*, as in the names of these medicines, anti-scorbutics, anti-venereal.

**ANTIADDES**, in anatomy, a name sometimes used for the glands, more usually called *tonsils*. See p. 296.

**ANTIADIAPHORISTS**, in church-history, the opposers of the Adiaphorists. See **ADIAPHORISTS**.

**ANTIBACCHIUS**, in ancient poetry, a foot consisting of three syllables, the two first long, and the last one short; such is the word *ambirë*.

**ANTIBES**, a sea-port town of Provence in France, situated on the Mediterranean, in E. long. 7°, N. lat. 43°, 40'.

**ANTICARDIUM**, in antiquity, the same with scrobiculum cordis.

ANTI-

- ANTICHAMBER**, an outer chamber for strangers to wait in, till the person to be spoken with is at leisure.
- ANTICHRESIS**, among civilians, the same with what in common law is called a *mortgage*. See **MORTGAGE**.
- ANTICHRIST**, among ecclesiastical writers, denotes a great adversary of Christianity, who is to appear upon the earth towards the end of the world. He is called in scripture, *The man of sin, the man of perdition, &c.*
- ANTICHTHONES**, in ancient geography, an appellation given to the inhabitants of opposite hemispheres.
- ANTICOR**, or **ANTICOEUR**, among farriers, an inflammation in the horse's throat, being the same with the quincy in mankind.
- ANTICOSTE**, an American island, situated before the mouth of the river St Lawrence, in 64° W. long. and 49° 52' N. lat.
- ANTICUS**, a term used by anatomists, importing, that the part with which it is joined stands before some others: Thus, we meet with *ferratus anticus, peroneus anticus*.
- ANTIDESMA**, in botany, a genus of the dioecia pentandria class. The calix of the male consists of 5 leaves; it has no corolla: The calix of the female is entire, gaping a little on one side; it has no corolla, but two styli, and a double valved capsule inclosed in the calix. There is but one species of the antidesma, viz. the alexeteria, a native of India.
- ANTIDICOMARIANITES**, in church-history, heretics, who maintained that the Virgin Mary did not preserve a perpetual virginity.
- ANTIDOTE**, among physicians, a remedy taken to prevent, or to cure the effects of poison, &c.
- ANTIEN**, or **ANCIEN**, a term applied to things which existed long ago: Thus we say, ancient nations, ancient customs, &c.
- ANTIEN**, in a military sense, denotes either the ensign, or the colours.
- ANTIEN**, in ships of war, the streamer or flag borne in the stern.
- ANTIGONIA**, the name of two cities, one in Epirus, now called *Gastro Argiro*, the other in Macedon, now *Cologna*.
- ANTIHECTICS**, in pharmacy, medicines good in hectic disorders.
- ANTILLES**, the same with the Caribbee islands.
- ANTILOGARITHM**, the complement of a logarithm.
- ANTILOGY**, in matters of literature, an inconsistency between two or more passages of the same book.
- ANTILYSSUS Pulvis**, a medicine consisting of equal parts of the lichen cinereus terrestris, and black pepper, reckoned good to prevent the rabies canina.
- ANTIMETABOLE**, in rhetoric, a figure whereby two things are set in opposition to each other.
- ANTIMONARCHICAL**, an appellation given to whatever opposes monarchical government. See **MONARCHY**.
- ANTIMONIALS**, in medicine, preparations of antimony. See **ANTIMONY**, and **CHEMISTRY**.
- ANTIMONIATED**, something impregnated with the virtues of antimony.
- ANTIMONY**, in natural history, one of the semi-metals. See **CHEMISTRY**, title, *Of metals*.
- ANTINOMIANS**, in church-history, certain heretics who first appeared about the year 1535; so called, because they rejected the law, as of no use under the gospel-dispensation, with other doctrines equally absurd.
- ANTIOCH**, a town of Syria, formerly its capital, but now in a ruinous condition; situated on the river Orontes, in 37° E. long. and 36° N. lat.
- ANTIOCHENUM**, in botany, a species of convolvulus. See **CONVOLVULUS**.
- ANTIPAGMENTA**. See **ANTEPAGMENTA**.
- ANTIPATHY**, a natural aversion of one body to another, in contradistinction to sympathy. See **SYMPATHY**.
- ANTIPERISTALTIC motion of the intestines**, the reverse of the peristaltic motion. See **PERISTALTIC**.
- ANTIPERISTASIS**, in the peripatetic philosophy, an imaginary intension or heightening of any quality by the opposition of its contrary.
- ANTIPHONY**, in music, the name which the Greeks gave to that kind of symphony which was executed in octave or double octave. It is likewise the answer made by one choir to another, when an anthem is sung between them.
- ANTIPIHRASIS**, in rhetoric, a figure by which in saying one thing we mean the contrary. See **IRONY**.
- ANTIPODES**, in geography, a name given to those inhabitants of the globe that live diametrically opposite to one another. They lie under opposite parallels, and opposite meridians. They have the same elevation of their different poles. It is midnight with the one, when it is noon-day with the other; the longest day with the one is the shortest with the other; and the length of the day with the one is equal to the night of the other. See **GEOGRAPHY**.
- ANTIPOPE**, in the Romish church, one elected pope in an irregular manner, in opposition to another.
- ATIPTOSIS**, in rhetoric, a figure which puts one case for another. See **CASE**.
- ANTIQUARY**, a person who studies and searches after monuments and remains of antiquity.
- There were formerly in the chief cities of Greece and Italy, persons of distinction called antiquaries, who made it their business to explain the ancient inscriptions, and give every other assistance in their power to strangers who were lovers of that kind of learning. There is a society of antiquaries in London, incorporated by the king's charter.
- ANTIQUATED**, something obsolete, out of date, or out of use.
- ANTIQU**, in a general sense, something that is ancient: but the term is chiefly used by sculptors, painters, and architects, to denote such pieces of their different arts as were made by the ancient Greeks and Romans. Thus we say, *an antique bust, an antique statue, &c.*
- ANTIQUITY**, signifies times or ages past long ago. Thus we say, *the heroes of antiquity, &c.* It is often used for the works or monuments of the ancients. Researches

searches into antiquity have frequently been useful. But these researches, unless they are conducted with judgment, are extremely liable to ridicule.

**ANTIRRHINUM**, in botany, a genus of the didyma angiosperma class. The calix consists of five leaves; the base of the corolla is bent backwards, and furnished with pectoria; the capsule is bilocular. There are 14 species of the antirrhinum, 10 of which are natives of Britain, viz. the cymbalaria, or ivy-leaved toad-flax; the elatine, or sharp-pointed fluellia; the sparium, or round-leaved fluellin; the arvense, or corn-blue toad-flax; the repens, or creeping toad-flax; the monospermum, or sweet-smelling toad-flax; the linaria, or common yellow toad-flax; the minus, or least toad-flax; the majus, or greater snapdragon; and the orontium, or least snapdragon. The linaria is said to be cathartic and diuretic; but it is not used in the shops.

**ANTISAGOGE**, in rhetoric, the same with concessio.

See **CONCESSIO**.

**ANTISCI**, in geography, people who live on different sides of the equator, whose shadows at noon are projected opposite ways. Thus the people of the north are Antiscii to those of the south, the one projecting their shadows at noon toward the north pole, and the other toward the south pole.

**ANTISCORBUTICS**, medicines good in scorbutical cases.

**ANTISEPTICS**, among physicians, a denomination given to all substances that resist putrefaction. Such as salts of all kinds, vinegar, myrrh, snake-root, pepper, &c.

**ANTISTOECHON**, in grammar, the using one letter instead of another, as *illi* for *illi*.

**ANTISTROPHE**, in grammar, a figure by which two things mutually depending on one another, are reciprocally converted; as *The servant of the master, the master of the servant*.

**ANTISTROPHE**, among lyric poets, that part of a song and dance in use among the ancients, which was performed before the altar, in returning from west to east, in opposition to strophe. See **STROPHE**, and **ODE**.

**ANTITACTÆ**, in church-history, a branch of Gnostics, who held, that God was good and just, but that a creature had created evil; and consequently that it is our duty to oppose this author of evil, in order to avenge God of his adversary.

**ANTITHENAR**, in anatomy, a name given to the adductor indicis. See p. 210.

**ANTITHESIS**, contrast, or opposition of words or sentiments; as,

*Though gentle, yet not dull,  
Strong without rage, without offending full.*

**ANTITHEF**, denotes either a quality or thing set in opposition to its contrary.

**ANTITHETARIUS**, in law, a person who endeavours to acquit himself by charging the accuser with the same fact.

**ANTITRAGUS**, *antitragus*, in anatomy, a muscle of the ear. See p. 294. par. 5.

**ANTITRINITARIANS**, a general name given to all Vol. I. No. 13.

those who deny the doctrine of the Trinity, and particularly to the Arians and Socinians.

**ANTITYPE**, among ecclesiastical writers, denotes a type corresponding to some other type or figure.

**ANTIVARI**, a sea-port town of Albania, situated on the gulph of Venice, in 19° 40' E. long. and 42° 10' N. lat. It is subject to the Turks.

**ANTIVETRIA**, a province or subdivision of Terra Firma, in South America, lying southwards of Carthagens.

**ANTLER**, among sportsmen, a start or branch of a deer's attire.

**Brow-ANTLER**, denotes the branch next the head; and **Eye-ANTLER**, the branch next above the brow-antles.

**ANTOECI**, in geography, those inhabitants of the earth who live under the same meridian, and at the same distance from the equator; the one toward the north, and the other toward the south. Hence they have the same longitude; and their latitude is also the same, but of a different denomination. They are in the same semicircle of the meridian, but opposite in parallels. They have precisely the same hours of the day and night, but opposite seasons; and the night of the one is always equal to the day of the other.

**ANTONIAN Waters**, medicinal waters of Germany, very pleasant to the taste, and esteemed good in many chronic and hypochondriac cases.

**ANTONIO**, one of the Cape de Verd islands, subject to the Portuguese, and situated in 26° W. long. and 18° N. lat.

**ANTONOMASIA** a form of speech, in which, for a proper name, is put the name of some dignity, office, profession, science, or trade; or when a proper name is put in the room of an appellative. Thus a king is called his majesty; a nobleman, his lordship. We say the philosopher instead of Aristotle; and the orator for Cicero: Thus a man is called by the name of his country, a German; an Italian; and a grave man is called a Cato, and a wise man a Solomon.

**ANTRIM**, the most north-east county of Ulster, in the king's om of Ireland. It is also the name of the chief town of the aforesaid county, situated at the north end of Loughneagh, in 6° 26' W. long. and 54° 45' N. lat.

**ANTRUM**, among anatomists, a term used to denote several cavities of the body; as the antrum highmoreanum, or that in the maxillary or jaw-bone, &c. See p. 162. par. 2.

**ANTWERP**, a beautiful city of the Austrian Netherlands, and capital of the marquisate of the same name. It stands on the eastern shore of the river Scheldt, about 25 miles north of Brussels, and in 4° 15' E. long. and 51° 15' N. lat.

**ANTYX**, in antiquity, denotes the circumference, or outermost round of a shield.

**ANVIL**, an iron instrument on which smiths hammer or forge their work, and is usually mounted on a firm wooden block.

**ANUS**, in anatomy, the extremity of the intestinum rectum, or orifice of the fundament. See p. 264. par. 2.

- ANWEILLER**, a small city of France, in the Lower Alsace, upon the river Queich.,
- ANZAR**, a city of Turkestan, near Catai, where Tamerlane died.
- ANZERMA**, a town of S. America, in the kingdom of Popajan, upon the river Cauca, situated in 47° W. long. and 4° S. lat.
- ANZUGUI**, a town in the island of Japan, upon the bay of Mecao.
- AONIDES**, in mythology, one of the many appellations of the muses, so called from Aonia, a part of ancient Bœotia.
- AORIST**, among grammarians, a tense peculiar to the Greek language, comprehending all the tenses, or rather expressing an action in an indeterminate manner, without any regard to past, present, or future.
- AOST**, a town of Piedmont in Italy, capital of the duchy of the same name, situated about 50 miles north of Turin, in 7° 10' E. long. and 45° 45' N. lat.
- APAGOGICAL** *Demonstration*, an indirect way of proof, by shewing the absurdity of the contrary.
- APALACHIAN Mountains**, a ridge of mountains of N. America, lying westward of the British plantations, and extending from 30° to 40° N. lat.
- APAMEA**, or *Ἰάμα*, a town of Syria, situated on the river Orontes, in 38° 30' E. long. and 34° N. lat.
- APAMEA** is also the name of a town of Phrygia, upon the river Marfyas; of a town of Midia, confining upon Parthia; and of a town of Bithynia, called by the Turks *Myrlea*.
- APANAGE**, or *APENNAGE*, in the French customs, lands assigned by a sovereign for the subsistence of his younger sons, which revert to the crown upon the failure of male issue in that branch to which the lands are granted.
- APARINE**, in botany, a synonyme of the utricularia and several other plants.
- APATHY**, a term in philosophy, denoting an utter privation of passion, and an insensibility of pain. Thus the Stoics affected an entire apathy, so as not to be ruffled, or sensible of pleasure or pain.
- APATIZATIO**, a law-term, signifying an agreement.
- APATURIA**, in Grecian antiquity, an Athenian festival, kept in honour of Bacchus. It was during this solemnity that the young people were registered in the respective wards of their fathers.
- APE**, the English name of the simia or monkey. See *SIMIA*.
- APELITES**, Christian heretics in the second century, who affirmed that Christ received a body from the four elements, which at his death he rendered back to the world, and so ascended into heaven without a body.
- APENE**, in antiquity, the chariot in which the images of the gods were carried on solemn occasions.
- APENNAGE**, in the French customs. See *APANAGE*.
- APENNINE**, a vast ridge of mountains, which runs through the middle of all Italy, from Savona, to the very strait that separates Italy from Sicily.
- APENRADE**, a town of Sleswic, or S. Jutland, situated on a bay of the Baltic sea, in 10° E. long. and 55° N. lat.
- APENZEL**, a town of Switzerland, capital of the canton of the same name, and situated in 9° E. long. and 47° 30' N. lat.
- APEPSY**, in medicine, denotes crudity, or a bad digestion.
- APER**, in zoology, a synonyme of the *fus scrofa*. See *SUS*.
- APER** is likewise a trivial name of a species of *ZEUS*. See *ZEUS*.
- APERIENTS**, in the materia medica, an appellation given to such medicines as facilitate the circulation of the humours by removing obstructions.
- The five greater aperient roots of the shops are smallage, fennel, asparagus, parsley, and butcher's broom; as the five lesser ones are grass, madder, eryngo, capers, and chammoc.
- APERTURE**, the opening of any thing, or a hole or cleft in any continuous subject.
- APERTURE**, in geometry, the space between two right lines which meet in a point and form an angle.
- APERTURE**, in optics, a round hole in a turned bit of wood or plate of tin, placed within the side of a telescope or microscope, near to the object-glass, by means of which more rays are admitted, and a more distinct appearance of the object is obtained.
- APERTURES**, or *APERATIONS*, in architecture, are used to signify doors, windows, chimneys, &c.
- APERTURA tabularum**, in law-books, the breaking open a last will and testament.
- APERTURA feudi**, in the civil law, signifies the loss of a feudal tenure, by default of issue to him to whom the feud was first granted.
- APETALOSE**, or *APETALOUS*, among botanists, an appellation given to such plants as have no flower-leaves.
- APEX**, in antiquity, the crest of a helmet, but more especially a kind of cap worn by the flamins.
- APEX**, among grammarians, denotes the mark of a long syllable, falsely called a long accent.
- APHACA**, in botany, a synonyme of the lathyrus. See *LATHYRUS*.
- APHÆRESIS**, in grammar, a figure by which a letter or syllable is cut off from the beginning of a word.
- APHÆRESIS**, that part of surgery which teaches to take away superfluities.
- APHANES**, in botany, a genus of the tetrandria digynia class. The calix is divided into eight parts; it has no corolla; and has two naked seeds. There is only one species of aphanes, viz. the *arvensis*, or parsley-piert, a native of Britain.
- APHELIUM**, or *APHELION*, in astronomy, is that point in any planet's orbit, in which it is farthest distant from the sun, being that end of the greater axis of the elliptical orbit of the planet most remote from the focus where the sun is.
- APHIS**, in zoology, a genus of insects belonging to the order of insecta hemiptera. The rostrum or beak of the aphid is inflected; the antennæ or feelers are longer than the thorax; it has four erect wings; the feet are of the ambulatory kind; and the belly often ends in two horns. There are 33 species of the aphid, all

1872

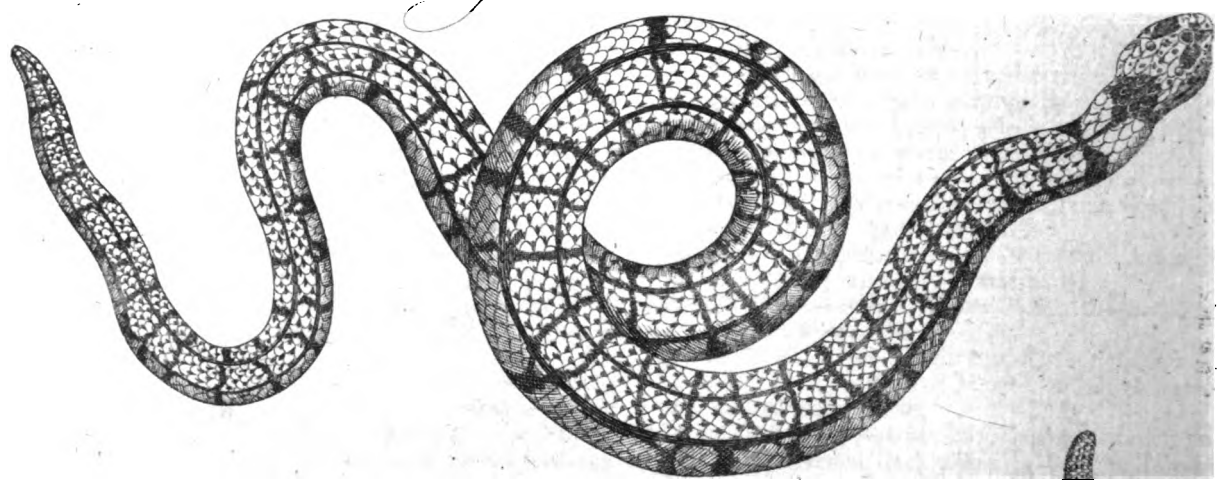
1872

1872

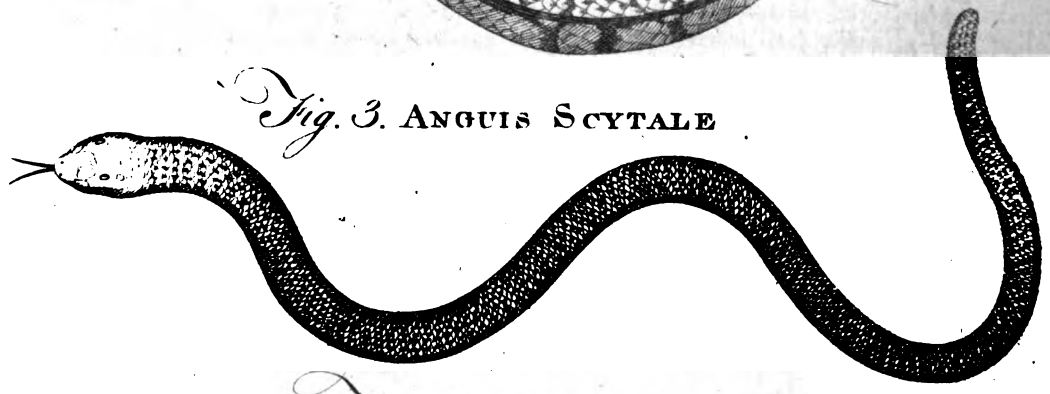
*Fig. 1.* ANGUIS MELEAGRIS



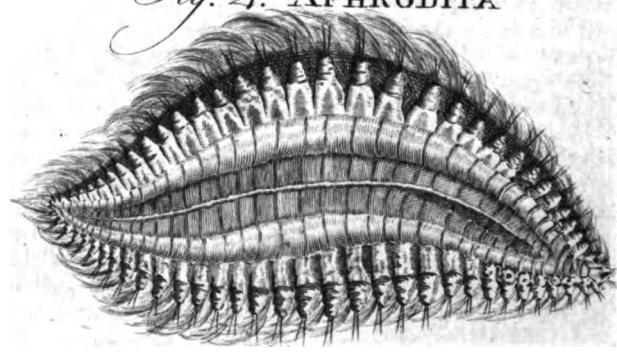
*Fig. 2.* ANGUIS MACULATA



*Fig. 3.* ANGUIS SCYTALE



*Fig. 4.* APHRODITA



*A. Bell Sculp. &c.*

of which are inhabitants of particular plants; and from this circumstance their trivial names are taken; as *aphis ribis, ulmi, rose, &c.*

**APHORISM**, a maxim, or principle, of a science; or a sentence which comprehends a great deal in a few words.

**APHRATIC**, in the maritime affairs of the ancients, were open vessels, without any decks.

**APHRODISIA**, in antiquity, festivals kept in honour of Venus, the most remarkable of which was that celebrated by the Cyprians.

**APHRODISIACS**, among physicians, medicines which increase the quantity of seed, and create an inclination to venery.

**APHRODITA**, in zoology, an insect of the order of *vermes mollusca*. The body of the aphrodita is oval, with many small tentacula or protuberances on each side, which serve as so many feet: The mouth is cylindrical, at one end of the body, and capable of being retracted, with two brittle tentacula. There are four species of this insect, *viz.* 1. The *aculeata*, with 32 tentacula, or feet, an inhabitant of the European seas. See Plate XXII. fig. 4. This figure is taken from the life. It was found on the shore of the frith of Forth, about a mile east from Leith, by Dr Letfom, and by him communicated to the proprietors of this work. Johnston, Seba, and other authors, have given figures of the aphrodita; but they are not so accurate as could be wished. 2. The *scabra*, of an oblong shape, scabrous on the back, with about 20 tentacula. 3. The *squamata*, with 24 feet, and scaly on the back. 4. The *imbricata*, is very like the former, only its scales are more glabrous.

**APHRODITES**, the same with *gemma veneris*. See **GEMMA**.

**APHRONITRE**, in natural history, a name given by the ancients to a particular kind of natrum.

**APHTHÆ**, in medicine, small, round, and superficial ulcers arising in the mouth. The principal seat of this disease, is the extremity of the excretory vessels, salival glands, and, in short, all glands that furnish a humour like the saliva, as the lips, gums, &c.

**APHUA** *cobites*, in ichthyology. See **GOBUS**.

**APHYLLANTHES**, or *Blue Montpellier Pink*, in botany, a genus of the *hexandria monogynia* class. There is but one species, *viz.* the *monspeliensis*, which grows in the high grounds near Montpellier. It is extremely like the *juncus*, only the flower has a corolla.

**APIARY**, a place where bees are kept.

**APIASTELLUM**, or **APIASTRUM**, in botany. See **MELISSA**.

**APIASTER**, in ornithology, the trivial name of a species of the *merops*. See **MEROPS**.

**APICES**, in botany, the same with *antheræ*. See **ANTHERÆ**.

**APIOS**, in botany. See **GLYCINE**.

**APIS**, or the **BEE**, in zoology, a genus of insects belonging to the order of *insecta hymenoptera*. The mouth is furnished with two jaws, and a proboscis infolded in a double sheath; the wings are four in number, the two foremost covering those behind when at rest: In

the anus or tail of the females and working bees, which are of no sex, there is a hidden sting. Linnæus enumerates no less than 55 species of the *apis*, *viz.* 1. The *longicornis*, or hairy yellow bee, with thread-like feelers, about the length of its body. 2. The *tumulorum*, or black bee, with yellow feet and jaws, and thread-like feelers, about the length of the body. 3. The *clavicornis*, or black bee, with clavated feelers, about the length of its body, and two yellow belts round the belly. 4. The *centuncularis*, or black bee, having its belly covered with yellow down. The nests of this species are made of rose-leaves curiously plaited in the form of a matt or quilt. 5. The *cineraria*, or black bee, with a white hairy breast, and a greenish belt round the belly. The above five species are all natives of Europe. 6. The *mexicana*, is a brownish bee, with bluish wings, and very large. It is a native of America. 7. The *carbonaria*, or reddish bee, with darkish green wings; it is about the size of the *mellefica*, or common honey-bee, and is found in Africa. 8. The *retusa*, or black bee, has its legs covered with down. 9. The *rufa*, or brownish bee, with a white front and dusky belly. 10. The *bicornis*, has two horns on its front, a black head, and a hairy belly. 11. The *maxillofa*, or black bee, with prominent jaws, short feelers, and a cylindrical belly, covered with a yellow down. 12. The *truncorum*, or black smooth-bee, with a white hairy front, and a yellow belly edged with white. 13. The *floriformis*, or black bee, with a cylindrical incurvated belly, having two tooth-like protuberances at the anus, and a kind of prickles on the hind-legs. This bee sleeps in flowers. 14. The *dentata*, or shining green bee, with black wings, and a kind of teeth on the hind thighs. The tongue of this bee is almost as long as its body. The nine last species are all natives of Europe. 15. The *cordata*, or shining green bee, with a belly shaped like a heart, and wings of a glass-colour. It is a native of the Indies. 16. The *helvola*, is an oblong reddish bee, with a white belly. 17. The *fabriciana*, or black bee, with an iron-coloured belly, and two yellow spots. 18. The *fuccinata*, has a yellow hairy breast, a black belly, and four white belts. The last three are natives of Europe. 19. The *zonata*, is brownish and hairy, with four bluish belts on the belly. It is a native of the Indies. 20. The *ænea*, is hairy, and of a copper colour. 21. The *cærulescens*, is brownish and hairy, with a greenish belly, margined with white indentations. 22. The *mellefica*, or honey-bee, is furnished with downy hairs, a dusky-coloured breast, and brownish belly; the tibiae of the hind-legs are ciliated, and transversely streaked on the inside. Each foot of this bee terminates in two hooks, with their points opposite to each other; in the middle of these hooks there is a little thin appendix, which, when unfolded, enables the bees to fasten themselves to glass or the most polished bodies. This part they likewise employ for collecting the small particles of wax which they find upon flowers, and for transmitting them to the middlemost joint of the two hinder feet, in which there is a little cavity, in the shape of a narrow spoon, surrounded by a number of hairs. When they have loaded their thighs with wax, they immediately carry it off to the

hive.

hive. The queen and drones, who never collect wax in this manner, have no such cavity. The belly of the bee is divided into six rings or joints. In the inside of the belly there is a small bladder or reservoir, in which the honey is collected, after having passed through the proboscis and a narrow pipe which runs through the head and breast. This bladder, when full of honey, is about the size of a small pea. The sting is situate at the extremity of the belly: It is a horny substance, and hollow within, for transmitting the venomous liquor, which lies in a bladder near the anus, into the wound. The sting is generally left in the wound, and frequently draws after it the poison-bag.

As the mellefica, or honey-bee, is both an useful insect, and endowed with peculiar instincts, we shall give a particular account of its nature and œconomy.

The queen is the only female in a hive; she is distinguished from the others by being taller, more of an oblong figure, and having ten joints in each feeler. She is likewise furnished with a sting. The fuci, males, or drones, are commonly about 1600 in a hive; they have no sting, and their feelers have eleven joints. The operariæ, spadonee, or working bees, are sometimes 20,000 in a hive; they have fifteen joints in their feelers, and are armed with stings.

After a new swarm is formed, the bees immediately begin to form their cells. They begin their work at the upper part of the hive, and continue it downwards, and from one side to the other. It is not easy to discover the particular manner of their working; for, notwithstanding the many contrivances used for this purpose, there are such numbers in continual motion, and succeed one another with such rapidity, that nothing but confusion appears to the sight. Some of them however have been observed carrying pieces of wax in their talons, and running to the places where they are at work, upon the combs. These they fasten to the work by means of the same talons. Each bee is employed but a very short time in this way; but there is so great a number of them that go on in a constant succession, that the comb increases very perceptibly. Besides these, there are others that run about beating the work with their wings and the hinder part of their body, probably with a view to make it more firm and solid.

The order they observe in the construction of their cells is this: They begin with laying the basis, which is composed of three rhombus's or lozenges. They build first one of the rhombus's, and draw faces on two of its sides; they then add a second rhombus to the first in a certain inclination, and draw two new faces on its two sides; and, last of all, they add a third rhombus to the two first, and raise on the two external sides of this rhombus two other faces; which completes the cell of an hexagonal figure.

Whilst part of the bees are occupied in forming the cells, others are employed in perfecting and polishing those that are new-modelled. This operation is performed by their talons, taking off every thing that is rough and uneven. These polishers are not so desultory in their operations as those that make the cells; they work long and diligently, never intermitting their labour, ex-

cepting to carry out of the cell the particles of wax which they take off in polishing. These particles are not allowed to be lost; others are ready to receive them from the polishers, and to employ them in some other part of the work.

Each comb has two rows of cells opposite to each other, which have their common bases. The thickness of every comb is something less than an inch, and the depth of the cells is about five lines. Almost all the combs are built with cells of this size; except a small number of a larger kind, that are destined for the worms that produce drones.

The bases of all the combs are placed at such a distance from one another, that, when the cells are finished, there is only a space left sufficient for the passage of two bees abreast. These combs are not continued from top to bottom, but are often interrupted, and have openings from one passage to another, which give a more easy and shorter communication.

The queen-bee is generally concealed in the most secret part of the hive, and is never visible but when she lays her eggs in such combs as are exposed to sight. When she does appear, she is always attended by ten or a dozen of the common sort, who form a kind of retinue, and follow her where-ever she goes with a sedate and grave tread. Before she lays her eggs, she examines the cells where she designs to lay them; and if she finds that they contain neither honey, wax, nor any embryo, she introduces the posterior part of her body into a cell, and fixes to the bottom of it a small white egg, which is composed of a thin white membrane, full of a whitish liquor. In this manner she goes on, till she fills as many cells as she has eggs to lay, which are generally many thousands. After the eggs lie four days in the cells, they appear in the form of small caterpillars; and generally lie twisted round, so that the two extremities touch each other. The bees then supply them with a little honey for food, the quantity of which they increase till the eighth day from the birth of the caterpillar. After this, the bees discover no more care about their young; but stop up the mouths of the cells with wax. The embryos lie in this state twelve days, during which time they undergo surprising changes. They first change their situation in the cells, and instead of being rolled up, they extend themselves along, and place their heads towards the mouth of the cell; after this, the head of the worm begins to have a small extension, which is the rudiment of the proboscis: Upon the head there is likewise a black point, and at a little distance from this point, a black streak upon the back: The first lineaments of the feet likewise appear; but they are very small. After the head is formed, and the proboscis lengthened, all the other parts display themselves successively; so that the whole worm or embryo is changed into an aurelia or nymphe, which is the fly almost perfect, except that it is yet white and soft, and wants that crust with which it is afterwards covered. By this transformation the worm is stripped of a white thin pellicle, which adheres to the sides of the cell. The young bee being stripped of this pellicle, and all the parts being unfolded by degrees, and changed through successive colours from yellow to black, arrives at



at perfection on the twentieth day; when she cuts, with her jaws or talons, the covering of wax upon the mouth of the cells, and issues out. When the young bees first get out of the cell, they appear drowsy, but soon acquire agility and command of their members; for they have often been observed to go to the fields, and return loaded with wax the same day that they issued from the cells.

As soon as a young bee quits its cell, one of the old ones takes off the wax-cover, and kneads and employs the wax for some other purpose: Another of them repairs and cleanses the cell, removing the pellicle and other fordes which was left by the young one.

It was observed above, that bees collect their wax from the pollen or farina of flowers, and carry it to the hive. When they arrive there, they support themselves on their two fore-feet, and make a buzz with their wings, thereby warning the bees within to assist them to unload; which they instantly do, each taking a small portion of the wax from the hinder-legs of the loaded ones, till the whole be exhausted. The wax is not only employed for the original construction of the combs and cells, but is collected and laid up in considerable quantities for the purposes of repairing any damage that may happen to the works during the winter, when they have no opportunity of collecting it in the fields, and likewise to stop up the mouths of the cells when full of honey or embryos. Bees have often been observed to dilute their wax, when too hard, by means of some liquor or saliva which they emit upon it, in order to render it soft and pliable for use.

The honey, as well as the wax, is collected from flowers. The honey, however, is extracted from a different part of the flower. In the flowers of many plants there are nectaria, or nectariferous glands, which secrete from the plant a pure transparent liquor, resembling virgin-honey both in taste and appearance, excepting that it is thicker. Perhaps all the change that this nectariferous juice undergoes, by being sucked up, and deposited in the honey-bag of the bee, is, that the more watery parts may probably be absorbed during the small time it remains there. The heat of the hive, after it is deposited in the cells, will still evaporate more of the watery parts, and bring it to the consistence of honey.

When a bee is collecting honey, she no sooner lights upon a flower than she extends her proboscis, and sucks up what she can find: If she cannot find a sufficient quantity to fill her bag in one flower, she immediately flies to another, and thus goes on till she has filled it. She then retires to the hive, goes to the cell, disgorges the honey, and again returns to the fields in quest of more. As the quantity carried home by one bee is but small, it requires the labour of many to fill a cell with honey. When the cells are full, they are immediately closed up with wax, if designed for winter-provision; if not, they are allowed to remain open for the common nourishment of the swarm.

Besides these capital instincts of bees, they are possessed of others, some of which are equally necessary for their preservation and happiness. They anxiously provide against the entrance of insects into the hive, by gluing up with wax the smallest holes in the skep. Some

stand as centinels at the mouth of the hive, to prevent insects of any kind from getting in. But if a snail, or other large insect, should get in, notwithstanding all resistance, they sting it to death, and then cover it over with a coat of wax, to prevent the bad smell or maggots which might proceed from the putrefaction of such a large animal. Bees are seldom overtaken with bad weather; they seem to be warned of its appearance by some particular feeling. Cold is a great enemy to them. To defend themselves against its effects during a cold winter, they crowd together in the middle of the hive, and buzz about, and thereby excite a warmth which is often perceptible by laying the hand upon the glass-windows of the hive. They seem to understand one another by the motions of their wings. When the queen wants to quit the hive, she gives a little buzz, and all the others immediately follow her example, and retire along with her. They expell the drones before the winter, so that, of several hundreds in a hive, not one can be seen after the month of October. This expulsion always occasions a furious battle between the drones and the working bees; but the latter being greatly superior in number, always prevail.

With regard to Hives, those made of straw are the best, on many accounts: They are not liable to be overheated by the rays of the sun; they keep out cold better than wood or any other materials; and the cheapness renders the purchase of them easy. As the ingenious Mr Wildman's hives are reckoned to be of a preferable construction to any other, we shall give an account of them in his own words.

“ My hives,” says he, “ are seven inches in height; and ten in width. The sides are upright, so that the top and bottom are of the same diameter. A hive holds nearly a peck. In the upper row of straw, there is a hoop of about half an inch in breadth, to which are nailed five bars of deals, full a quarter of an inch in thickness, and an inch and quarter wide, and half an inch asunder from one another; a narrow short bar is nailed at each side, half an inch distant from the bars next them, in order to fill up the remaining parts of the circle; so that there are in all seven bars of deal, to which the bees fix their combs. The space of half an inch between the bars allows a sufficient and easy passage for the bees from one hive to another. In order to give great steadiness to the combs, so that, upon moving the hive, the combs may not fall off, or incline out of their direction, a stick should be run through the middle of the hive, in a direction directly across the bars, or at right angles with them. When the hives are made, a piece of wood should be worked into the lower row of straw, long enough to allow a door for the bees, of four inches in length, and half an inch in height.

“ The proprietor of the bees should provide himself with several flat covers of straw, worked of the same thickness as the hives, and a foot in diameter, that so it may be of the same width as the outside of the hives. Before the cover is applied to the hive, a piece of clean paper, of the size of the top of the hive, should be laid over it, and a coat of cow-dung, which is the

“ least

“ least apt to crack of any cement easily to be obtained,  
 “ should be laid all round the circumference of the hive.  
 “ Let the cover be laid upon this, and made fast to the  
 “ hive with a packing-needle and pack-thread, so that  
 “ neither cold nor vermin may enter.

“ Each hive should stand single on a piece of deal, or  
 “ other wood, somewhat larger than the bottom of the  
 “ hive: That part of the stand which is at the mouth of  
 “ the hive should project some inches, for the bees to rest  
 “ on when they return from the field. This stand should  
 “ be supported upon a single post, two and a half feet  
 “ high; to which it should be screwed very securely,  
 “ that high winds, or other accidents, may not blow  
 “ down both stand and hive. A quantity of foot mixed  
 “ with barley-chaff should be strewed on the ground  
 “ round the post, which will effectually prevent ants,  
 “ slugs, and other vermin, from rising up to the hive.  
 “ The foot and chaff should, from time to time, be re-  
 “ newed as it is blown or washed away: Though, as it  
 “ is sheltered by the stand, it remains a considerable time,  
 “ especially if care be taken that no weeds rise through  
 “ it. Weeds, indeed, should not be permitted to rise  
 “ near the hive, for they may give shelter to vermin  
 “ which may be hurtful to the bees.

“ The stands for bees should be four yards asunder;  
 “ or, if the apiary will not admit of so much, as far a-  
 “ sunder as may be, that the bees of one hive may not  
 “ interfere with those of another hive, as is sometimes  
 “ the case, when the hives are near one another, or on  
 “ the same stand: For the bees, mistaking their own  
 “ hives, light sometimes at the wrong door, and a fray  
 “ ensues, in which one or more may lose their lives.

“ The person who intends to erect an apiary, should  
 “ purchase a proper number of hives at the latter part  
 “ of the year, when they are cheapest. The hives should  
 “ be full of combs, and well stored with bees. The  
 “ purchaser should examine the combs, in order to know  
 “ the age of the hives. The combs of that season are  
 “ white, those of the former year are of a darkish yel-  
 “ low; and where the combs are black, the hives should  
 “ be rejected, because old hives are most liable to ver-  
 “ min and other accidents.

“ If the number of hives wanted were not purchased in  
 “ the autumn, it will be necessary to remedy this neglect  
 “ after the severity of the cold is past in the spring. At  
 “ this season, bees which are in good condition will get  
 “ into the fields early in the morning, return loaded,  
 “ enter boldly, and do not come out of the hive in bad  
 “ weather; for when they do, this indicates they are  
 “ in great want of provisions. They are alert on the  
 “ least disturbance, and by the loudness of their humming  
 “ we judge of their strength. They preserve their hives  
 “ free from all filth, and are ready to defend it against  
 “ every enemy that approaches.

“ The summer is an improper time for buying bees,  
 “ because the heat of the weather softens the wax, and  
 “ thereby renders the combs liable to break, if they are  
 “ not very well secured. The honey too being then  
 “ thinner than at other times, is more apt to run out  
 “ of the cells; which is attended with a double disad-  
 “ vantage, namely, the loss of the honey, and the dan-

“ ing of the bees, whereby many of them may be de-  
 “ stroyed. A first and strong swarm may indeed be  
 “ purchased; and, if leave can be obtained, permitted  
 “ to stand in the same garden till the autumn; but if  
 “ leave is not obtained, it may be carried away in the  
 “ night after it has been hived.

“ I suppose, that in the stocks purchased, the bees  
 “ are in hives of the old construction. The only direc-  
 “ tion here necessary is, that the first swarm from these  
 “ stocks should be put into one of my hives; and that  
 “ another of my hives should in a few days be put under  
 “ the old stock, in order to prevent its swarming again.”

Bees never swarm till the hive be too much crowded  
 by the young brood. It is this circumstance that indu-  
 ces a part of the hive to think of finding a more commo-  
 dious habitation. With this view they single out a queen  
 from among the young, with whom they take wing;  
 and where-ever she leads, the rest follow. They first  
 begin to swarm in May, or in the end of April, but ear-  
 lier or later according to the warmth of the season:  
 They seldom swarm before ten in the morning, and sel-  
 dom later than three in the afternoon. We may know  
 when they are about to swarm, by clusters of them hang-  
 ing on the outside of the hive, and by the drones appear-  
 ing abroad more than usual: But the most certain sign is,  
 when the bees refrain from flying into the fields, though  
 the season be inviting. Just before they take flight, there  
 is an uncommon silence in the hive; after this, as soon as  
 one takes flight, they all follow. Before the subsequent  
 swarmings, there is a great noise in the hives, which is  
 supposed to be occasioned by a contest whether the young  
 or the old queen should go out. When the bees of a  
 swarm fly too high, they are made to descend lower, by  
 throwing handfuls of sand or dust among them, which  
 they probably mistake for rain. For the same purpose,  
 it is usual to beat on a kettle or frying-pan: This prac-  
 tice may have taken its rise from observing that thunder  
 or any great noise prompts such bees as are in the fields  
 to return home.

When the bees settle in swarming, they collect them-  
 selves in a heap, and hang to each other by their feet.  
 When they settle in two separate divisions, it generally  
 proceeds from there being two queens in the swarm. In  
 that case, each cluster of them may be hived separately;  
 or one of the queens must be destroyed, to prevent the  
 commotions which the bees would raise in order to de-  
 stroy her. All the motions and settling of a swarm are  
 directed by the queen. If she be weak, and fall to the  
 ground, the whole swarm fall down along with her; if  
 she rest upon a branch of a tree, they accompany her;  
 and if the queen be caught into a hive, the swarm will  
 instantly follow her. When a swarm is too few in num-  
 ber for a hive, another may be added, provided the queen  
 belonging to it be destroyed. If that precaution be not  
 taken, a battle will ensue, in which not only one of the  
 queens is killed, but frequently a great many of the  
 working bees.

Several methods of taking the wax and honey, with-  
 out destroying the bees, have of late been practised. Mr  
 Wildman's seems both to be the easiest and safest: “ Re-  
 “ move (says he) the hive from which you would take  
 “ the

" the wax and honey into a room, into which admit but  
 " little light, that it may appear at first to the bees as if  
 " it was late in the evening. Gently invert the hive,  
 " placing it between the frames of a chair, or other  
 " steady support, and cover it with an empty hive, keep-  
 " ing that side of the empty hive raised a little which is  
 " next the window, to give the bees sufficient light to  
 " get up into it. While you hold the empty hive, stea-  
 " dily supported on the edge of the full hive, between  
 " your side and your left arm, keep striking with the  
 " other hand all round the full hive from top to bottom,  
 " in the manner of beating a drum, so that the bees  
 " may be frightened by the continued noise from all  
 " quarters; and they will in consequence mount out of  
 " the full hive into the empty one. Repeat the strokes  
 " rather quick than strong round the hive, till all the  
 " bees are got out of it, which in general will be in a-  
 " bout five minutes. It is to be observed, that the fuller  
 " the hive is of bees, the sooner they will have left it.  
 " As soon as a number of them have got into the empty  
 " hive, it should be raised a little from the full one,  
 " that the bees may not continue to run from the one to  
 " the other, but rather keep ascending upon one another.  
 " So soon as all the bees are out of the full hive, the  
 " hive in which the bees are must be placed on the stand  
 " from which the other hive was taken, in order to  
 " receive the absent bees as they return from the fields.  
 " If this is done early in the season, the operator  
 " should examine the royal cells, that any of them that  
 " have young in them may be saved, as well as the combs  
 " which have young bees in them, which should on no  
 " account be touched, though, by sparing them, a good  
 " deal of honey should be left behind. Then take out  
 " the other combs with a long, broad, and pliable knife,  
 " such as the apothecaries make use of. The combs  
 " should be cut from the sides and crown, as clean  
 " as possible, to save the further labour of the bees,  
 " who must lick up the honey spilt, and remove eve-  
 " ry remains of wax; and then the sides of the hive  
 " should be scraped with a table-spoon, to clear away  
 " what was left by the knife. During the whole of this  
 " operation, the hive should be placed inclined to the  
 " side from which the combs are taken, that the honey  
 " which is spilt may not daub the remaining combs. If  
 " some combs were unavoidably taken away, in which  
 " there are young bees, the parts of the combs in which  
 " they are should be returned into the hive, and secured  
 " by sticks, in the best manner possible. Place the hive  
 " then for some time upright, that any remaining hon-  
 " ey may drain out. If the combs are built in a di-  
 " rection opposite to the entrance, or at right angles  
 " with it, the combs which are the furthest from the  
 " entrance should be preferred, because there they are  
 " best stored with honey, and have the fewest young bees  
 " in them.  
 " Having thus finished taking the wax and honey,  
 " the next business is to return the bees to their old  
 " hive; and for this purpose place a table, covered  
 " with a clean cloth, near the stand, and giving the  
 " hive in which the bees are a sudden shake, at the same  
 " time striking it pretty forcibly, the bees will be shaken

" on the cloth. Put their own hive over them imme-  
 " diately, raised a little on one side, that the bees may  
 " the more easily enter; and when all are entered, place  
 " it on the stand as before. If the hive in which the  
 " bees are, be turned bottom uppermost, and their own  
 " hive be placed over it, the bees will immediately ascend  
 " into it, especially if the lower hive is struck on the  
 " sides to alarm them.

" The chief object of the bees during the spring and  
 " beginning of summer, is the propagation of their kind.  
 " Honey during that time is not collected in such quanti-  
 " ties as it is afterwards: and on this account it is  
 " scarcely worth while to rob a hive before the latter  
 " end of June; nor is it safe to do it after the middle  
 " of July, lest rainy weather prevent their restoring the  
 " combs they have lost, and laying in a stock of honey  
 " sufficient for the winter, unless there is a chance of  
 " carrying them to a rich pasture."

Mr Wildman, by his dexterity in the management of  
 bees, has lately surpris'd the whole kingdom. He can  
 order a swarm to light where he pleases, almost instanta-  
 neously; he can order them to settle on his head, then  
 remove them to his hand; command them to depart and  
 settle on a window, table, &c. at pleasure. We shall  
 subjoin his method of performing these feats, in his own  
 words: " Spectators (says he) wonder much at my at-  
 " taching bees to different parts of my body, and with  
 " much to be possessed of the secret means by which I  
 " do it. I have unwarily promised to reveal it; and am  
 " therefore under a necessity of performing that promise:  
 " but while I declare, that their fear and the queen are  
 " the chief agents in these operations, I must warn my  
 " readers that there is an art necessary to perform it,  
 " namely practice, which I cannot convey to them, and  
 " which they cannot speedily attain; yet till this art is  
 " attained, the destruction of many hives of bees must  
 " be the consequence; as every one will find on their  
 " first attempt to perform it.

" Long experience has taught me, that as soon as I  
 " turn up a hive, and give it some taps on the sides and  
 " bottom, the queen immediately appears, to know the  
 " cause of this alarm; but soon retires again among her  
 " people. Being accustomed to see her so often, I readily  
 " perceive her at first glance; and long practice has en-  
 " abled me to seize her instantly, with a tenderness that  
 " does not in the least endanger her person. This is of  
 " the utmost importance; for the least injury done to her  
 " brings immediate destruction to the hive, if you have  
 " not a spare queen to put in her place, as I have too  
 " often experienced in my first attempts. When pos-  
 " sessed of her, I can, without injury to her, or exci-  
 " ting that degree of resentment that may tempt her  
 " to sting me, slip her into my other hand, and, return-  
 " ing the hive to its place, hold her there, till the bees,  
 " missing her, are all on wing, and in the utmost confu-  
 " sion. When the bees are thus distressed, I place the  
 " queen where-ever I would have the bees to settle. The  
 " moment a few of them discover her, they give notice  
 " to those near them, and those to the rest; the know-  
 " ledge of which soon becomes so general, that in a few  
 " minutes they all collect themselves round her; and are

“ so happy in having recovered this sole support of their state, that they will long remain quiet in their situation. Nay, the scent of her body is so attractive of them, that the slightest touch of her, along any place or substance, will attach the bees to it, and induce them to pursue any path she takes.

“ My attachment to the queen, and my tender regard for her precious life, makes me most ardently wish that I might here close the detail of this operation, which, I am afraid, when attempted by unskilful hands, will cost many of their lives; but my love of truth forces me to declare, that, by practice, I am arrived at so much dexterity in the management of her, that I can, without hurt to her, tie a thread of silk round her body, and thus confine her to any part in which she might not naturally wish to remain; or I sometimes use the less dangerous way of clipping her wings on one side.

“ I shall conclude this account in the manner of C. Furius Cresinus, who being cited before the Curule Edile and an assembly of the people, to answer to a charge of forcery, founded on his reaping much larger crops from his small spot of ground, than his neighbours did from their extensive fields, produced his strong implements of husbandry, his well-fed oxen, and a hale young woman, his daughter; and, pointing to them, said, These, Romans, are my instruments of witchcraft; but I cannot shew you my toil, my sweats, and anxious cares. So may I say, These, Britons, are my instruments of witchcraft; but I cannot shew you my hours of attention to this subject, my anxiety and care for these useful insects; nor can I communicate to you my experience, acquired during a course of years.”

We shall conclude this history of the HONEY-BEE with the following experiments for preventing a waste of honey, and preserving the lives of bees during the winter, communicated by a gentleman near the banks of the Tweed. “ I have tried several experiments for preserving the lives of bees during the winter; and tho’ in general with little success, yet I think I have reason to continue, and advise others to follow, what I practised last winter. The method is very simple, and not expensive, for it is no other than keeping the bees in a cold and dark place.

“ My reason for trying this experiment, was my having observed, that a certain degree of cold brought upon the bees a stupor; and that the same degree of cold continued, kept them in the same state, till they were brought into a warmer situation, which immediately restored their life and vigour\*.

\* This observation is confirmed by what Mr White says, *That bees which stand on the north-side of a building, whose height intercepts the sun's beams all the winter, will waste less of their provisions, almost by half, than others which stand in the sun; for, seldom coming forth, they eat little, and yet in the spring are as forward to work and swarm as those which had twice as much honey in the autumn before.* See the Rev<sup>d</sup>. Mr White's method of preserving bees. Third edition.

“ With this view I kept two hives shut up in a dark cold out-house, from the middle of September to the middle of April, without ever letting them see light: Upon their being set out in the warmer air, they recovered immediately, and shewed an appearance of more strength than the hives did which had been kept out in the usual way. This appearance of strength continued during the summer, and they multiplied faster than I had ever observed them do before. They were rather later in swarming this year than in former summers; but the same was the case with many hives in this neighbourhood: and even though this should always happen, yet I think other advantages will do more than overbalance it. Could I go into the country early in the spring, to look after the bees myself, I would bring them into the open air some weeks sooner, carefully attend to the changes of the weather, and shut up the doors of the hive on a bad day: but this degree of care can scarcely be expected from servants and gardeners, who have many other things to attend to.

“ I intend to have four hives put up this season, in the coldest dark place I can find; and as an ice-house is the steadiest and greatest cold we have, one or two of my friends who have ice-houses, have promised to put a hive upon the ice. By all accounts, the cold in Siberia does not kill the bees there; and in Russia, where the winters are extremely severe, bees produce much honey: so I think there is not any danger to be feared from any degree of cold we can expose the bees to.

“ If success continues to attend this experiment of keeping the bees asleep all the winter and spring, without consuming their honey, a great point will be gained; especially as Mr Wildman has taught us to take the honey without killing the bees: for, by what I have observed in this country, our bees are lost chiefly by being tempted to go out in a clear sun in the spring, though perhaps a frosty wind blows, and chills them, so as to prevent their being able to return to the hive; or an early warmth induces the queen to lay eggs, and a number of young bees are bred, which consume the little provision left, before the fields can afford any supply.”

#### EXPLANATION of PLATE XXIII.

FIGURE 1. Is the queen bee. 2. Is the drone. 3. Is the working bee. 4. Represents the bees hanging to each other by the feet, which is the method of taking their repose. 5. The proboscis or trunk, which is one of the principal organs of the bees, wherewith they gather the honey and take their nourishment. 6. One of the hind-legs of a working-bee, loaded with wax. 7. A comb, in which the working bees are bred. The cells are the smallest of any. Two of them have the young bees inclosed. A royal cell is suspended on one side. 8. A comb in which the drones are bred, being larger than the former; the young drones being included in several of them; with two royal cells suspended on the side. 9. A similar comb, in which the royal cell is fixed in the middle of the comb; and several common cells are sacrificed to serve as a basin and

Plate XXIII.

*Fig. 1.*



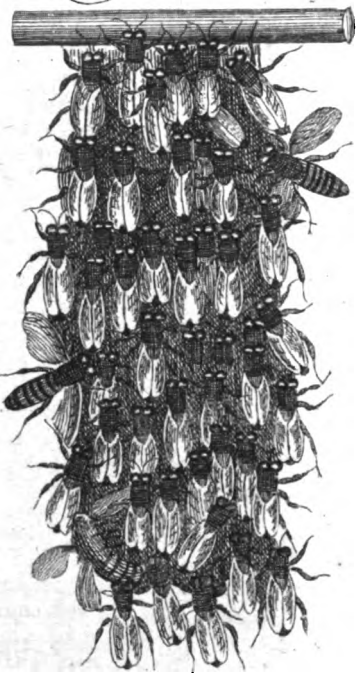
*Fig. 2.*



*Fig. 3.*

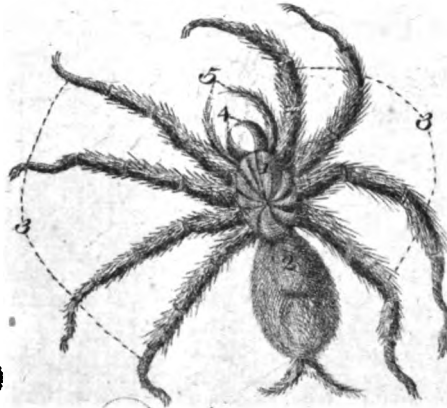


*Fig. 4.*



*Fig. 10*

ARANEAE TARANTULA



*Fig. 5.*



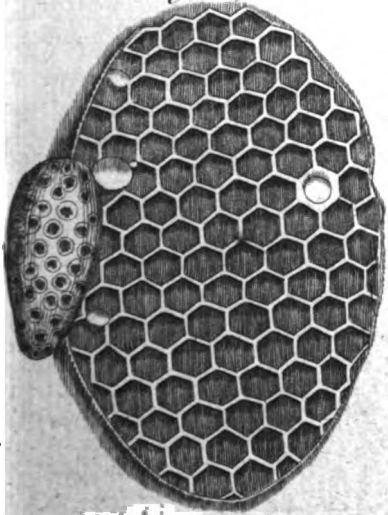
*Fig. 6*



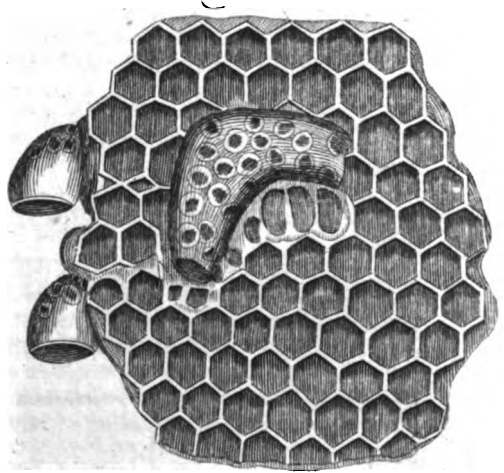
*Fig. 8.*



*Fig. 7.*



*Fig. 9.*





and support to it. In general, the royal cells are suspended on the side of a comb, as in fig. 7, 8. To the side of fig. 9. two royal cells are begun, when they resemble pretty much the cup in which an acorn lies. The other royal cells have the young queens included in them.

The 23d species is the *apis cucularia*, or hairy bee, with an iron-coloured breast, and yellow belly. This species is very like the *mellefica*; they build their nests in dry sandy places. 24. The *variegata*; the breast and belly are variegated with white and black spots; the legs are of an iron colour. It is a native of Europe. This species sleep in the *geranium phœum*, or spotted-crane's-bill. 25. The *rostrata* is distinguished by the upper lip being inflected, and of a conical shape, and by the belly being invested with bluish belts. They build their nests in high sandy grounds, and there is but one young in each nest. 26. The *argillôsa*, or iron-coloured bee, has an inflected rostrum, and a crooked belly, with one joint. It is a native of Surinam. 27. The *lagopoda* is of a greyish colour, with an emarginated anus. 28. The *manicata*, or black bee, with hairy fore-legs; the belly is spotted with yellow; and the anus is tridentated. 29. The *quatuor-dentata*, is of a dusky colour, with five white belts on the belly, and the anus has four teeth-like protuberances; each intermediate tooth is forked. The last three species are natives of Europe. 30. The *fasciata* has a yellowish back, and a black belt round the edge of each wing; the breast is white; the belly is variegated with black and white; the legs are covered with black hair; and the feelers are green. It is a native of the Cape of Good Hope. 31. The *barbara*, or black bee, with a yellow edging round the breast, is about the size of an ant; the feelers are like threads. It is a native of Barbary. 32. The *conica*, or yellow bee, with an acute conical belly, and the margins of the joints or segments white; it dwells in cavities of the earth. 33. The *annulata*, or black bee, with a black front, and black rings round the legs. 34. The *ruficornis* has two iron-coloured spots on the breast and feelers; the belly is spotted with yellow. 35. The *ferruginea*, or smooth black bee, with the feelers, mouth, belly, and feet of an iron colour. This is a small bee, and supposed to be of an intermediate kind between the bee and wasp. The last three are natives of Europe. 36. The *ichneumonea*; the rostrum or snout is a erect horn; the belly is petiolated and black; and the breast is interspersed with shining gold-coloured sutures or indented-lines; the antennæ are green. It is a native of America. 37. The *cariosa* is a yellowish hairy bee; and the feet and front are of a bright yellow colour. It builds in the rotten trees of Europe. 38. The *violacea* is a red bee, and very hairy, with bluish wings. It is a native of Europe. The *violacea* is said to perforate trees, and hollow them out in a longitudinal direction; they begin to build their cells at the bottom of these holes, and deposit an egg in each cell, which is composed of the farina of plants and honey, or a kind of gluten. 39. The *caffra* is also red, and covered with hair; the hind part of the breast and fore-part of the belly are

yellowish. 40. The *carolina* is a red hairy bee, with the upper part of the belly yellow. It is a native of Carolina. 41. The *terrestris* is black and hairy, with a white belt round the breast, and a white anus. It builds its nest very deep in the earth. 42. The *horrorum* is a black hairy bee, with the fore part of the breast and belly yellow. 43. The *pratorum*, or black hairy bee, with the fore part of the breast yellow, and a blackish anus. 44. The *lapidaria*, or red hairy bee, with a yellow anus. It builds in holes of rocks. 45. The *sylvarum*, or pale hairy bee, with a black belt on the breast, and a reddish anus. 46. The *muscorum*, or yellow hairy bee, with a white belly. It builds in mossy grounds. 47. The *hyporum*, or yellow hairy bee, with a black belt on the belly, and a white anus. 48. The *lucorum*, or yellow hairy bee, with a white anus. The last eight species are all natives of Europe. 49. The *brasiliarum*, or pale-red hairy bee, with the basis of the thighs black. This is a very large bee, every where covered with a testaceous skin. It is a native of America. 50. The *acervorum* is red and hairy, and builds below ground. 51. The *subterranea* is red and hairy, with a dusky anus; it likewise builds below ground. 52. The *surinamensis* is a black hairy bee, with the whole belly, excepting the first joint or segment, yellow. It is a native of Surinam. 53. The *æstuans*, or black hairy bee, with a yellow breast. 54. The *tropica*, or black hairy bee, with the hind part of the belly yellow. The two last are natives of the warm climates. 55. The *alpina* is a hairy bee, with a black breast, and yellow belly. It inhabits the mountains of Lapland.

**APIUM**, or **PARSLEY**, in botany, a genus of the pentandria digynia class. The fruit is of an oval shape and streaked; the involucre consists of one leaf; and the petals are inflected. There are only two species of apium, *viz.* the *petroselinum*, a native of Sardinia; and the *graveolens*, a native of Britain. The seeds of the *petroselinum* are carminative, and the root is used as an aperient.

**APIVORUS** *Buteo*, in ornithology, a synonyme of a species of falco. See **FALCO**.

**APLUDA**, in botany, a genus of the polygamia monœcia class. The calix is a bivalved gluma; the stamules of the female are sessile, and the male stamules are furnished with pedunculi; the female has no calix; the corolla has a double valve; there is but one stylus, and one covered seed. The male has three stamina. There are three species of *apluda*, *viz.* the *mutica*, *aristata*, and *zeugites*, all natives of the Indies.

**APOBATERION**, in antiquity, a valedictory speech or poem made by a person on departing out of his own country, and addressed to his friends or relations.

**APOCALYPSE**, one of the sacred books of the New Testament, so called from its containing revelations concerning several important doctrines of Christianity.

**APOCARPASUM**, a poisonous drug, otherwise called *carpasum*.

**APOCHYLISMA**, in pharmacy, the same with **ROB**. See **ROB**.

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APO-

- APOCOPE**, among grammarians, a figure which cuts off a letter or syllable from the end of a word; as *ingeni* for *ingenii*.
- APOCRISIARIUS**, in antiquity, an officer who delivered the messages of the emperor. He became afterwards chancellor, and kept the seals. It was also a title given to a bishop's resident at court, to the pope's deputy at Constantinople, and to the treasurer of a monastery.
- APOCRUSTICS**, in medicine, the same with repellents. See **REPELLENTS**.
- APOCRYPHAL**, denotes something dubious, and is more particularly applied to such books as are not admitted into the canon of scripture, being either not acknowledged as divine, or rejected as heretical and spurious. The apocryphal books, according to the sixth article of the church of England, are to be read for example of life and instruction of manners; but it doth not apply them to establish any doctrine.
- APOCYNUM**, in botany, a genus of the pentandria digynia class. The corolla is campaniform, or shaped like a bell. There are five species, all natives of America.
- APODICTICAL**, among philosophers, a term importing a demonstrative proof, or systematical method of teaching.
- APODOSIS**, in rhetoric, the same with axiosis. See **AXIOSIS**.
- APODYTERIUM**, in the ancient baths, the apartments where persons dressed and undressed.
- APOGEE**, in astronomy, that point of the orbit of a planet or the sun which is farthest from the earth.
- APOLLINARIAN games**, in Roman antiquity, an appellation given to certain theatrical entertainments celebrated annually in honour of Apollo.
- APOLLINARIANS**, or **APOLLINARISTS**, in church-history, a sect of heretics who maintained, that Jesus Christ had neither a rational human soul, nor a true body.
- APOLLINARIS**, in botany. See **HYOSCYAMUS**.
- APOLLONIA**, in antiquity, an annual festival celebrated by the Ægialians in honour of Apollo.
- APOLLONIA**, in geography, a promontory of Africa, upon the coast of Guinea, near the mouth of the river Mancu.
- APOLOGUE**, in matters of literature, an ingenious method of conveying instruction by means of a feigned relation called a moral fable.
- The only difference between a parable and an apologue is, that the former being drawn from what passes among mankind, requires probability in the narration; whereas the apologue, being taken from the supposed actions of brutes, or even of things inanimate, is not tied down to the strict rules of probability. Æsop's fables are a model of this kind of writing.
- APOLOGY**, a Greek term, literally importing an excuse, or defence of some person or action.
- APOMELI**, among ancient physicians, a decoction of honey and vinegar, much used as a detergent, promoter of stool, urine, &c.
- APONEUROSIS**, among physicians, a term sometimes used to denote the expansion of a nerve or tendon in the manner of a membrane; sometimes for the cutting off a nerve; and, finally, for the tendon itself.
- APONOGETON**, in botany. See **ZANNICHELLIA**.
- APOPHASIS**, a figure in rhetoric, by which the orator, speaking ironically, seems to wave what he would plainly insinuate: as, *Neither will I mention those things, which if I should, you, notwithstanding, could neither confute nor speak against them.*
- APOPHLEGMATIZANTS**, in pharmacy, medicines proper to clear the head from superfluous phlegm, whether by spitting, or by the nose.
- APOPHTHEGM**, a short, sententious, and instructive remark, pronounced by a person of distinguished character. Such are the apophthegms of Plutarch, and those of the ancients collected by Lycosthenes.
- APOPHYGE**, in architecture, a concave part or ring of a column, lying above or below the flat member. The French call it *le cenge d'en bas*, or *d'en haut*; the Italians, *cavo di basso*, or *di sopra*; and also, *il vivo di basso*. The apophyge originally was no more than the ring or ferril, at first fixed on the extremities of wooden pillars, to keep them from splitting; which afterwards was imitated in stone.
- APOPHYSIS**, in anatomy, a process or protuberance of a bone.
- APOPLEXY**, a distemper in which the patient is suddenly deprived of all his senses, and of voluntary motion. See **MEDICINE**, title, *Apoplexy*.
- APORIA**, is a figure in rhetoric, by which the speaker shews, that he doubts where to begin for the multitude of matter, or what to say in some strange and ambiguous thing; and doth, as it were, argue the case with himself. Thus, Cicero says, *Whether he took them from his fellows more impudently, gave them to a harlot more lasciviously, removed them from the Roman people more wickedly, or altered them more presumptuously, I cannot well declare.*
- APOSIOPESIS**, a form of speech, by which the speaker, through some affection, as sorrow, bashfulness, fear, anger, or vehemency, breaks off his speech before it be all ended. A figure, when speaking of a thing, we yet seem to conceal it, though indeed we aggravate it; or when the course of the sentence begun is so stayed, as thereby some part of the sentence, not being uttered, may be understood; as, *I might say much more, but modestly commands silence.*
- APOSTACY**, the abandoning the true religion. The primitive Christian church distinguished several kinds of apostacy. The first, of those who went over entirely from Christianity to Judaism; the second, of those who mingled Judaism and Christianity together; and the third, of those who complied so far with the Jews as to communicate with them in many of their unlawful practices, without making a formal profession of their religion. But the fourth sort was of those who, after having been sometimes Christians, voluntarily relapsed into Paganism.
- APOSTASIS**, in medicine, the same with abscess. See **ABSCESS**.
- APOSTATE**, one who deserts his religion. Among the



the Romanists, it signifies a man who, without a legal dispensation, forsakes a religious order of which he had made profession. Hence,

**APOSTATA** *capiendo*, in the English law, a writ that formerly lay against a person, who having entered into some order of religion, broke out again, and wandered up and down the country.

**A POSTERIORI**, or demonstration *à posteriori*. See **DEMONSTRATION**.

**APOSTHUME**, or **APOSTEM**; the same with abscess. See **ABSCESS**.

**APOSTIL**, in matters of literature, the same with a marginal note.

**APOSTLE** properly signifies a messenger or person sent by another upon some business; and hence, by way of eminence, denotes one of the twelve disciples commissioned by Jesus Christ to preach the gospel.

The apostles are usually represented with their respective badges: Thus Peter is painted with the keys; Paul, with a sword; Andrew, with a cross; James the greater, with a pilgrim's staff; James the less, with a fuller's pole; John, with a cup and winged serpent flying out of it; Bartholomew, with a knife; Philip, with a long staff, the upper end of which is formed into a cross; Thomas, with a lance; Matthew, with a hatchet; Matthias, with a battle-axe; Simon, with a saw; and Jude, with a club.

**APOSTLES** *creed*. See **CREED**.

**APOSTLES** *ointment*. See **OINTMENT**.

**APOSTOLICI**, an early sect of Christians, who pretended to lead their lives in imitation of the apostles. They condemned marriage.

**APOSTROPHE**, in rhetoric, a figure by which the orator, in a vehement commotion, turns himself on all sides, and applies to the living and dead, to angels and to men, to rocks, groves, &c. Thus Adam, in Milton's Paradise Lost,

*O woods, O fountains, hillocks, dales, and bowers,  
With other echo, &c.*

**APOSTROPHE**, in grammar, the contraction of a word by the use of a comma; as *call'd* for *called*, *tho'* for *though*.

**APOTACTITES**, in church-history, a name given to the Apostolici, from the shew they made of renouncing the world more than other men. See **APOSTOLICI**.

**APOTHECARY**, one who practises the art of pharmacy.

**APOTHEOSIS**, in antiquity, a ceremony by which the ancient Romans complimented their emperors and great men, after their death, with a place among the gods. It is described as follows. After the body of the deceased had been burnt with the usual solemnities, an image of wax, exactly resembling him, was placed on an ivory couch, where it lay for seven days, attended by the senate and ladies of the highest quality in mourning; and then the young senators and knights bore the bed of state through the *via sacra* to the old forum, and from thence to the *campus martius*, where it was deposited upon an edifice built in form of a pyramid. The bed being thus placed amidst a quantity of spices and other combustibles, and the knights having made a solemn procession round the pile, the new emperor, with a torch in his hand, set fire to it, whilst an eagle,

let fly from the top of the building, and mounting in the air with a firebrand, was supposed to convey the soul of the deceased to heaven; and thenceforward he was ranked among the gods.

**APOTOME**, in geometry, the difference between two incommensurable lines.

**APOTOME**, in music, the difference between a greater and lesser semi-tone, expressed by the ratio 128 : 125.

**APOZEM**, in medicine, the same with decoction. See **DECOCTION**.

**APPARATUS**, a term used to denote a complete set of instruments, or other utensils, belonging to any artist or machine: thus we say a surgeon's apparatus.

**APPARENT**, in a general sense, something that is visible to the eyes, or obvious to the understanding.

**APPARENT**, among mathematicians and astronomers, denotes things as they appear to us, in contradistinction from real or true: thus we say, the apparent diameter, distance, magnitude, place, figure, &c. of bodies.

**APPARENT** *heir*, in Scots law, the person entitled to succeed to the estate of a defunct, before he is actually entered. See **SCOT'S LAW**, title, *Succession in heritable rights*.

**APPARITION**, in a general sense, denotes simply the appearance of a thing. In a more limited sense, it is used for a spectre or ghost.

**APPARITOR**, among the Romans, a general term to comprehend all attendants of judges and magistrates appointed to receive and execute their orders. Apparitor, in England, is a messenger that serves the process of a spiritual court, or a beadle in a university who carries the mace.

**APPARURA**, among old law-writers, signifies furniture or tackle, particularly that belonging to a plough.

**APPAUMEE**, in heraldry, denotes one hand extended with the full palm appearing, and the thumb and fingers at full length.

**APPEAL**, in law, the removal of a cause from an inferior to a superior court or judge, when a person thinks himself aggrieved by the sentence of the inferior judge. Appeals lie from all the ordinary courts of justice to the House of Lords. In ecclesiastical causes, if an appeal is brought before a bishop, it may be removed to the archbishop; if before an archdeacon, to the court of arches, and thence to the archbishop; and from the archbishop's court, to the king in chancery.

**APPEAL** *of main*, is the accusing one that has maimed another.

**APPEARANCE**, in a general sense, the exterior surface of a thing, or that which immediately strikes the senses.

**APPEARANCE**, in law, signifies a defendant's suing a common or special bail, on any process issued out of a court of judicature.

**APPELLANT**, in a general sense, one who appeals. See **APPEAL**.

**APPELLANTS**, in church-history, an appellation given to such of the catholic clergy, as appeal from the constitution unigenitus, to a general council.

**APPELLATIVE**. Words and names are either common or proper. Common names are such as stand for universal ideas, or a whole rank of beings, whether general

neral or special. These are called *appellatives*. So fish, bird, man, city, river, are common names; and so are trout, eel, lobster; for they all agree to many individuals, and some to many species.

**APPELLEE**, among lawyers, the person against whom an appeal is brought. See **APPEAL**.

**APPENDIX**, in literature, a treatise added at the end of a work, to render it more complete.

**APPERCEPTION**, or **ADPERCEPTION**, a term used by Leibnitz and his followers for consciousness.

**APPERTINANCES**, the same with appurtenances. See **APPURTENANCES**.

**APPETITE**, in a general sense, the desire of enjoying some object supposed to be conducive to our happiness.

**APPETITE**, in medicine, a certain painful or uneasy sensation, always accompanied with a desire to eat or drink.

**APPLAUSE**, an approbation of something, signified by clapping the hands, still practised in theatres.

**APPLE**, the fruit of the *pyrus malus*, or apple-tree. See **PYRUS**.

**APPLE of the eye**, a name not unfrequently given to the pupil. See p. 289.

**APPLEBY**, the chief town of the county of Westmoreland, situated on the river Eden, in  $2^{\circ} 26'$  W. long. and  $54^{\circ} 30'$  N. lat. It sends two members to parliament.

**APPLICATE**, or **ORDINATE** *applicata*, in geometry. See **ORDINATE**.

**APPLICATION**, in a general sense, is the laying two things together, in order to discover their agreement or disagreement.

**APPLICATION**, in geometry, is used either for division, for applying one quantity to another, whose areas, but not figures, shall be the same; or, for transferring a given line into a circle, or other figure, so that its ends shall be in the perimeter of the figure.

**APPLICATION**, among divines, a term used to signify the same as imputation. See **IMPUTATION**.

**APPOGIATURA**, in music, a small note inserted by the practical musician, between two others, at some distance.

**APPOINTE'E**, a foot-soldier, or officer in the French army, who receives a greater pay than others of the same rank, in consideration of his valour or long service.

**APPOINTE'E**, in heraldry, the same as *aguisee*: Thus we say, a cross appointee, to signify that which two angles at the end cut off, so as to terminate in points.

**APPOINTMENT**, in a general sense, the same as assignment. See **ASSIGNATION**. In a more restrained sense, it signifies a pension given by princes and noblemen to retain certain persons in their service.

**APPORTIONMENT**, in law, the division of a rent into parts, in the same manner as the land out of which it issues is divided.

**APPOSITION**, in grammar, the placing two or more substantives together in the same case, without any copulative conjunction between them; as, *Ardebat Alexim delicias domini*.

**APPRAISING**. See **APPRYISING**.

**APPREHENSION**; in logic, the first or most simple act of the mind, whereby it perceives, or is conscious of some idea. See **PERCEPTION**, and **LOGIC**.

**APPRYISING**, in Scots law, the name of that act by which a creditor formerly carried off the estate of his debtor for payment. It is now abolished, and adjudications are appointed in place of it. See **SCOTS LAW**, title, *Appryisings and Adjudications*.

**APPROACH**, or **APPROACHING**; in a general sense, the acceding or coming together of two or more things.

**APPROACHES**, in fortification, the works thrown up by the besiegers, in order to get nearer a fortress, without being exposed to the enemies cannon.

**APPROACHING**, in gardening, the inoculating or ingrafting the sprig of one tree into another, without cutting it off from the parent-tree.

**APPROACHING**, in fowling, a method of getting nearer the birds by means of a machine, made of hoops and boughs of trees, within which the sportsman conceals himself.

**APPROPRIARE** *communiam*, in law, is to discommon, that is, to inclose any parcel of land that before was open and common.

**APPROPRIARE** *ad honorem*, to bring a manor within the liberty of an honour. See **MANOR**, and **HONOUR**.

**APPROPRIATION**, in law, a severing of a benefice ecclesiastical to the proper and perpetual use of some religious house, or dean and chapter, bishoprick, or college; because, as persons ordinarily have no right of fee simple, these, by reason of their perpetuity, are accounted owners of the fee simple; and therefore are called *proprietors*. To an appropriation, after the licence obtained of the king in chancery, the consent of the diocesan, patron, and incumbent, are necessary, if the church be full; but, if the church be void, the diocesan and the patron, upon the king's licence, may conclude.

**APPROXIMATION**, in arithmetic and algebra, the coming nearer and nearer to a root, or other quantity sought, without expecting to be ever able to find it exactly.

**APPUI**, in the menage, the sense of the action of the bridle in the horseman's hand. Thus we say, a horse has no *appui*, when he cannot suffer the bit to bear never so little upon the parts of the mouth. To give a horse a good *appui*, he should be galloped, and put often back.

**APPULSE**, in astronomy, the approach of a planet towards a conjunction with the sun or any of the fixed stars.

**APRICOT**, in botany, the English name of the *prunus Armeniaca*. See **PRUNUS**.

**APRIL**, in chronology, the fourth month of the year, containing only 30 days.

**A PRIORI**, a kind of demonstration. See **DEMONSTRATION**.

**APRON**, in gunnery, the piece of lead which covers the touch-hole of a cannon. See **CANNON**.

**APSIS**, in astronomy, a term used indifferently for either of the two points of a planet's orbit, where it is at the greatest or least distance from the sun or earth. Hence

Hebce the line connecting these points is called the *line of the apses*. See ASTRONOMY.

**ARIS**, among ecclesiastical writers, denotes the inner part of the ancient churches, answering to the modern choir. It is also used for the bishop's throne, and sometimes for the ambo. See AMBO.

**APSYRTUS**, in botany. See MARRUBIUM.

**APTE**, a small city of Provence, in France, situated about 25 miles north of Aix, in 5° 20' E. long. and 43° 50' N. lat.

**APTERA**, the term used by Linnæus for his seventh order of insects, comprehending such as have no wings.

**APTHANE**, a title anciently given to the highest degrees of nobility in Scotland. See THANE.

**APTOTE**, among grammarians, an indeclinable noun, or one which has no variation of cases.

**APUA**, in ichthyology, an obsolete name of the gobius. See GOBIUS.

**APULIA**, or **PUGLIA**, in geography. See PUGLIA.

**APUS**, in ornithology, the trivial name of a species of hirundo. See HIRUNDO.

**APYCNI Suppi**, in music, sounds distant one or more octaves, and yet concord.

**APYCNOS**, in music, is said of the diatonic genus, on account of its having spacious intervals, in comparison of the chromatic and enharmonic. See DIATONIC, CHROMATIC, &c.

**APYREXY**, among physicians, denotes the intermission of a fever.

**AQUA**, a term frequently met with in the writings of physicians, chemists, &c. for certain medicines, or menstrua, in a liquid form, distinguished from each other by peculiar epithets; as,

**AQUA alexiteria**, a water distilled from mint, sea-worm-wood, and angelica; and said to be good in malignant and pestilential cases.

**AQUA alatrifera**, alum-water, a solution of water and white vitriol; esteemed good in ulcers and cutaneous eruptions.

**AQUA fortis**, a corrosive liquor, made by distilling purified nitre with calcined vitriol, or rectified oil of vitriol, in a strong heat; the liquor, which rises in fumes red as blood, being collected, is the spirit of nitre or aqua fortis; which serves as a menstruum for dissolving of silver, and all other metals, except gold. But if sea-salt, or sal ammoniac be added to aqua fortis, it commences *aqua regia*. Aqua fortis is commonly held to have been invented about the year 1300; though others will have it to have been known in the time of Moses. It is serviceable to refiners, in separating silver from gold and copper; to the workers in mosaic, for staining and colouring their woods; to dyers, in their colours, particularly scarlet; and to other artists, for colouring bone and ivory. With aqua fortis bookbinders marble the covers of books, and diamond-cutters separate diamonds from metalline powders. It is also used in etching copper or brass plates. See CHEMISTRY, *Of the nitrous acid*.

**AQUA marina**, a name by which the jewellers call the beryl, on account of its sea-green colour. See BERYL.

**AQUA mercurialis**, a solution of sublimate of mercury, and a little mercury, in aqua regia.

**AQUA mirabilis**, the wonderful water, is prepared of cloves, galangals, cubebs, mace, cardomoms, nutmegs, ginger, and spirit of wine, digested 24 hours, then distilled. It is a good and agreeable cordial.

**AQUA omnium florum**, in pharmacy, the water distilled from the dung of cows, when they go to graze; in English, *All-flower-water*.

**AQUA regia**, an acid corrosive spirit, so called, because it serves as a menstruum to dissolve gold, commonly esteemed the king of metals. Its basis, or essential ingredient, is common sea-salt, the only salt in nature which will operate on gold. It is commonly prepared by mixing common sea-salt, or sal ammoniac, or the spirit of them, with spirit of nitre, or common aqua fortis. See CHEMISTRY, title, *Of aqua regia*.

**AQUA secunda**, denotes aqua fortis, which has been used to dissolve some metal.

**AQUA sulphurata**, the same with gas sulphuris. See GAS.

**AQUA vita**, the water of life, a name given to malt spirits in contradistinction from brandy.

**AQUA vitriolica cerulea**, a solution of blue vitriol and alum, with some spirit of vitriol, in water; recommended in inflammatory and putrid cases.

**AQUÆ pavor**, in medicine. See HYDROPHOBIA.

**AQUÆDUCT**, in hydraulics and architecture, a conveyance made for carrying water from one place to another. Those of the ancient Romans were surprisingly magnificent. That which Lewis XIV. built near Maintenon, for carrying the Bucq to Versailles, is perhaps the greatest now in the world: It is seven thousand fathoms long, with two thousand five hundred and sixty fathoms of elevation, and contains two hundred and forty-two arcades.

**AQUA-NEGRA**, a small town of the Mantuan; in Italy, situated upon the Chiese, in 9° E. long. and 45° 10' N. lat.

**AQUAPENDENTE**, a city of the ecclesiastical state, in Italy, situated upon the river Paglia, abounding in waters.

**AQUARIANS**, in church-history, an ancient sect of heretics, who, under pretence of abstinence, made use of water instead of wine in the eucharist.

**AQUARIUS**, in astronomy, a constellation which makes the eleventh sign in the zodiac, marked thus ♒. See ASTRONOMY.

**AQUARTIA**, in botany, a genus of the tetrandria monogynia class. There is only one species, called *aculeata*, a native of Europe.

**AQUATIC**, in natural history, an appellation given to such things as live or grow in the water.

**AQUAVIVA**, a town of the kingdom of Naples, and province of Barri.

**AQUEDUCT**. See AQUÆDUCT.

**AQUELEIA**, a patriarchal city of Italy, near the end of the gulph of Venice, situated in 13° 30' E. long. and 46° 20' N. lat.

**AQUEOUS**, in a general sense, something partaking of the nature of water, or that abounds with it.

**AQUEOUS humour**, in anatomy. See p. 289.

**AQUIFOLIUM**, in botany, the trivial name of a species of *ilex*. See *ILEX*.

**AQUILA**, in ornithology, a synonyme of the *falco*, or eagle. See *FALCO*.

**AQUILA**, in astronomy, a constellation of the northern hemisphere. See *ASTRONOMY*.

**AQUILA**, in geography, a large city of Abruzzo, in the kingdom of Naples, situated in  $14^{\circ} 20'$  E. long. and  $42^{\circ} 40'$  N. lat.

**AQUILEGIA**, or **COLUMBINE**, in botany, a genus of the polyandria pentagynia class. It has no calix; the petals are five, and five horn-like nectaria are inserted betwixt each petal; it has also five separate capsules. There are three species of aquilegia, *viz.* the vulgaris, or common columbine, a native of Britain; the alpina, a native of Switzerland; and the Canadensis, a native of Virginia and Canada. The aquilegia is reckoned to be an aperient, but has long since given way to more powerful medicines.

**AQUILICIUM**, or **AQUILICIANA**, in Roman antiquity, sacrifices performed in times of excessive drought, to obtain rain of the gods.

**AQUILINE**, something belonging to, or resembling an eagle; Thus, an aquiline nose is one bent somewhat like an eagle's beak.

**AQUINO**, a ruinous city in the province of Lavoro, in the kingdom of Naples, situated in  $14^{\circ} 30'$  E. long. and  $41^{\circ} 30'$  N. lat.

**ARA**, in astronomy, a southern constellation, containing eight stars.

**ARABET**, a town of Turkish Tartary, situated near the Palus Mæotis. It is fortified with two castles; and is the place where the khan keeps his stud of horses, which are reckoned to be about seven thousand in number.

**ARABIA**, a large country of Asia, having Turkey on the north, Persia and the gulf of Persia on the east, the Indian ocean on the south, and the Red sea and isthmus of Suez on the west; and situated between  $35^{\circ}$  and  $60^{\circ}$  E. long. and between  $12^{\circ}$  and  $30^{\circ}$  N. lat.

Arabia, though subject to a great many different princes, is only considered by geographers as subdivided into the three grand divisions of Arabia Felix, Arabia Deserta, and Arabia Petrea.

**ARABIAN**, or **ARABIC**, in a general sense, something belonging to Arabia: Thus we say, Arabian characters, Arabian language, &c. See *HEBREW*.

**Gum ARABIC**, the name of a gum which distills from the Egyptian acacia tree. It is brought to us from Turkey, in small irregular masses or strings of a pale yellow colour. The true gum-arabio is rarely to be met with in the shops, gum-senega being usually sold in place of it: This resembles the other, but is generally in large rough pieces. The true kind is preferred as a medicine; but the other is cheapest and strongest, and therefore preferred for mechanical uses. It is given, from a scruple to two drams, in hoarseness; a thin acrimonious state of the juices, and where the natural mucus of the intestines is abraded. It is likewise an in-

redient in the white decoction, chalk-julep, and other compositions.

**ARABICI**, a sect of heretics, who held, that the soul both dies and rises again with the body.

**ARABIS**, in botany, a genus of the tetradynamia filiquosa class. The generic mark is taken from four nectariferous glands which lie on the inside of each leaf of the calix. There are eight species of arabis, none of which are natives of Britain, except the thaliana, or coded mouse-ear.

**ARABISM**, in language, an idiom peculiar to the Arabian language.

**ARABLE lands**, those which are fit for tillage, or which have been formerly tilled.

**ARACK**, **ARRACK**, or **RACK**, a spirituous liquor imported from the E. Indies, used by way of dram and in punch. The word *arack* is an Indian name for strong waters of all kinds; for they call our spirits and brandy *English arack*. But what we understand by the name *arack*, is really no other than a spirit procured by distillation from a vegetable juice called *toddy*, which flows by incision out of the cocoa-nut tree. There are divers kinds of it; single, double, and treble distilled. The double distilled is commonly sent abroad, and is preferred to all other aracks of India.

**ARACAN**, the capital city of a small kingdom, situated on the north-east part of the gulf of Bengal, in  $93^{\circ}$  E. long. and  $20^{\circ} 30'$  N. lat.

**ARACARI**, in ornithology, the trivial name of a species of ramphastos. See *RAMPHASTOS*.

**ARACH**, the chief city of Arabia Petrea, situated in  $49^{\circ}$  E. long. and  $30^{\circ} 20'$  N. lat.

**ARACHIS**, in botany, a genus of the diadelphia decandria class. There is only one species, *viz.* the hypogæa, a native of America. The calix is divided into two parts; and the capsule or pod is cylindrical, and contains two seeds.

**ARACHNOIDES**, in anatomy, an appellation given to several membranes, as the tunic of the crystalline humour of the eye, the external lamina of the pia mater, and one of the coverings of the spinal marrow.

**ARÆOMETER**, an instrument to measure the gravity of liquors, which is usually made of a thin glass ball, with a taper neck, sealed at the top, there being first as much mercury put into it as will keep it swimming in an exact posture. The neck is divided into two parts, which are numbered, that sh by the depths of its descent into any liquor, its lightness may be known by these divisions.

**ARÆOSTYLE**, in architecture, a term used by Vitruvius, to signify the greatest interval which can be made between columns.

**ARÆOTICS**, in medicine, remedies which rarefy the humours, and render them easy to be carried off by the pores of the skin.

**ARAF**, among the Mahometans. See *ARARAF*.

**ARAFAT**, a mountain of Arabia, near Mecca, where the Mahometans believe that Abraham offered to sacrifice Ishmael.

**ARAGON**, a province of Spain, having Biscay and the Pyrenean mountains on the north, Catalonia on the

the east, Valencia on the south, and the two Castiles on the west.

**ARAGNEE**, in fortification, signifies the branch, return, or gallery of a mine. See **MINE**.

**ARALIA**, in botany, a genus of the pentadria pentagynia class. The involucre is an umbella; the calix has five-teeth, and is above the fruit; the corolla has five petals; and the berry has five seeds. There are five species of aralia, all natives of the Indies.

**ARALIASTRUM**, in botany. See **PANAX**.

**ARANDA de Duero**, a city of Old Castile, in Spain, situated on the Duero; between Osma and Valladolid; so called, to distinguish it from another city of the same name, situated upon the Ebro.

**ARANEA**, the **SPIDER**, a genus of insects belonging to the order of aptera, or insects without wings. All the species of spiders have eight legs, with three joints in each, and terminating in three crooked claws; eight eyes, two before, two behind, and the rest on the sides of the head. The mouth consists of two claws or talons, denticulated like a saw. A little below the point of the claw, there is a small hole, through which the spider emits a kind of poison. These claws are the weapons with which they kill flies, &c. for their food. The belly or hinder part is separated from the head and breast by a small thread-like tube. The skin or outer surface is a hard polished crust. Spiders have five tubercles or nipples at the extremity of the belly, whose apertures they can enlarge or contract at pleasure. It is through these apertures that they spin a gluey substance with which their bellies are full. They fix the end of their threads by applying these nipples to any substance, and the threads lengthen in proportion as the animal recedes from it. They can stop the issuing of the threads by contracting the nipples, and re-ascend, by means of the claws on their feet, much in the same manner as some men warp up a rope. When the common house-spider begins her web, she generally chooses a place where there is a cavity, such as the corner of a room, that she may have a free passage on each side, to make her escape in case of danger. Then she fixes one end of her thread to the wall, and passes on to the other side, dragging the thread along with her, (or rather the thread follows her as she proceeds), till she arrives at the other side, and there fixes the other end of it. Thus she passes and repasses, till she has made as many parallel threads as she thinks necessary for her purpose. After this, she begins again and crosses these by other parallel threads, which may be named the *woof*. These are the coils or snares which she prepares for entangling flies, and other small insects, which happen so light upon it. But, besides this large web, she generally weaves a small cell for herself, where she lies concealed watching for her prey. Betwixt this cell and the large web, she has a bridge of threads, which, by communicating with the threads of the large one, both give her early intelligence when any thing touches the web, and enables her to pass quickly in order to lay hold of it. There are many other methods of weaving peculiar to different species of spiders. But,

as they are all intended for the same purpose, it is needless to give particular descriptions of them.

Linnaeus enumerates 47 species of spiders, viz. 1. The diadema, has a globular reddish belly, with a white cross; It inhabits the birch-tree. 2. The reticulata, has a reticulated round belly, and is dusky or purple on the back. It frequents gardens. 3. The cucurbitina, has a globular yellow belly, with a few black spots. It lives in the leaves of trees, and incloses its eggs in a soft net. 4. The calycina, with a round pale yellow belly, and two hollow points. It lives in the cups of flowers, after the flower-leaves have fallen off, and catches bees, and other flies, when they are in search of honey. 5. The octopunctata, with a roundish yellow belly, four black marks on each side, and a red anus. It is a native of Sweden. 6. The bipunctata, with a round red belly, and two hollow points. It frequents windows. 7. The arundinacia, with a white roundish belly, and dusky-coloured spots. It frequents reeds. 8. The angulata, with an oval belly; the fore-part of the sides form an acute angle. It frequents trees. 9. The domestica, or common house-spider, has a dusky oval belly, with five contiguous black spots. 10. The trilineata, with a white belly, and three longitudinal lines of blackish spots. It lives in woods. 11. The riparia, has an oval glazed black belly, and a yellowish forked hairy anus. It lives in the sandy banks of rivers. 12. The labyrinthica; with a dusky oval belly, a whitish indented line, and a forked anus. The web of this species is horizontal, with a cylindrical well or tube in the middle. 13. The quadrilineata, has a roundish yellow belly, and four spots and four purple lines on each side. It is a native of Sweden. 14. The redimita, has an oblong yellow belly, and a red oval ring on the back. It frequents gardens. 15. The corollata, has a black oval belly, and an oval white ring on the back. It dwells upon plants. 16. The fumigata, has a dusky oval belly, and two white points at the base. It lives in the fields. 17. The montana, has a white oval belly, with ash-coloured spots. It lives in trees. 18. The sanguinolenta, has a blood-coloured belly; with a black longitudinal line. It is a native of Spain. 19. The notata, has an oval dusky-coloured belly; with white transverse lines. 20. The rufipes, has a dusky belly, and reddish legs. It most frequently lives among nettles. 21. The nocturna, has a black belly, with two white points, and a little white half-moon at the base of the anus. 22. The extensa; has a long greenish shining belly, and its legs are extended longitudinally. It frequents marshy grounds. 23. The fimbriata, has a black oblong belly, with a white line on each side, and dusky-coloured legs. It lives in water, upon the surface of which it runs with great swiftness. 24. The sexpunctata, has an oblong belly, and three pair of hollow points. It lives in woods. 25. The flavissima, has a smooth oblong belly of a very yellow colour. It is a native of Egypt. 26. The bimaculata, has a chestnut-coloured roundish belly, with two white points. 27. The flavipes, has an oblong belly, and the last joints of the legs, excepting the third pair, are hairy and clawed. It is a native of America. 28. The quadripunctata, has a black oblong belly, and four hol-

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low points. It is to be met with in windows, &c. 29. The holoserica, has an ovalish belly covered with a down like velvet; at the base, or under part, it has two yellow spots. It is found in the folded leaves of plants. 30. The senoculata, is distinguished from the rest by having only six eyes. 31. The avicularia, has a convex round breast, hollowed transversely in the middle. It is a native of America, and feeds upon small birds, insects, &c. The bite of this spider is as venomous as that of the serpent. 32. The spinimobilis, has moveable black spines on its legs. It is a native of Surinam. 33. The venatoria, is a hairy spider, with a round, convex breast, about the same size with the belly, which is oval. It is a native of America. 34. The ocellata, has three pair of eyes on its thighs. It is about the same size with the tarantula, of a pale colour, with a black ring round the belly, and two large black spots on the sides of the breast. It is a native of China. 35. The tarantula, Plate XXIII. fig. 10. The breast (1), and belly (2), are of an ash-colour; the legs (3) are likewise ash-coloured, with blackish rings on the under part; the fangs, or nippers (4), are red on the inner side, the rest being blackish; (5) is the antenna or feelers: Two of its eyes are larger than the other, red, and placed in the front; four other eyes are placed in a transverse direction towards the mouth; the other two are nearer the back. It is a native of Italy, Cyprus, Barbary, and the E. Indies. The breast and belly are about two inches long, terminated by two short tails. This figure was taken from the life, in the island of Cyprus, by Alex<sup>r</sup> Drummond, Esq; late consul at Aleppo. The bite of the tarantula is said to occasion an inflammation in the part, which in a few hours brings on sickness, fainting, and difficulty of breathing: The person afterwards is affected with a delirium, putting himself into the most extravagant postures. However, this is not always the case; for they are sometimes seized with a deep melancholy. The same symptoms return annually, in some cases, for several years, and at last terminate in death. Music is said to be the only cure. It induces the patient to dance, and sweat out the poison. 36. The scelenica, is a black jumping spider, with three white semi-circular lines across its body. It frequents old walls. 37. The truncorum, is a black jumping spider, with white spots on the back. It frequents walls, and old wood. 38. The rupestris, is a jumping spider, with black spots on its belly, which is edged with red and white in the middle. It frequents walls and trees. 39. The aquatica, is of a livid colour, with an oval belly, and a transverse line, and two hollowed points. It frequents the fresh waters of Europe; and lodges, during the winter, in empty shells, which it dextrously shuts up with a web. 40. The faccata, has an oval belly of a dusky iron colour. It lives in the ground, and carries a sack with its eggs, where-ever it goes. This sack it glues to its belly, and will rather die than leave it behind. 41. The palustris, has an oblong cloudy belly, with two white lines on each side. It frequents marshy grounds. 42. The virescens, has an oblong greenish yellow belly, with white lines on the sides. It frequents gardens. 43. The viatica, has a roundish plain belly,

with the four last legs shorter than the others. It frequents gardens, and sits upon its eggs. 44. The levi-pea, has a depressed rhomboidal belly, with its legs extended in a transverse direction. It is found on trees and walls. 45. The tetracantha, has a lunated belly, and is found in St Thomas's isle. 46. The cancriformis, has a globular belly, and is a native of America. 47. The spinosa, has eight spines on its back, and a conical belly. It is a native of America. ARANEA *conchea*, the spider-shell, a name given to several species of *murax*. See *MURAX*. ARANEUS, in zoology, the trivial name of a species of cancer. See *CANCER*. ARANJUEZ, a palace belonging to the king of Spain, beautifully situated on the banks of the Tagus, about fifteen or sixteen miles eastward of Madrid. ARAPABACA, in botany, a synonyme of the *spigelia*. See *SPIGELIA*. ARARAT, the name anciently given to part of mount Caucasus, lying between the Euxine and Caspian seas, and where Noah's ark rested. ARARAUNA, in ornithology, the trivial name of a species of *psittacus*. See *PSITTACUS*. ARASH, a city of the province of Asgar, in the kingdom of Fez, where the river Luca falls into the Western Ocean. ARAUCO, a city of Chili, in S. America, situated on a river of the same name, in 78° W. long. and 37° S. lat. ARAXES, or ARRAS, a river of Persia. See *ARRAS*. ARAYA, one of the most celebrated capes in S. America, forming the north point of the river Oronoque. See *ORONOQUE*. ARBALET, the same with cross-bow. See *CROSS-BOW*. ARBELA, or IRBIL, in geography. See *IRBIL*. ARBITER, in law, a person to whose decision any dispute or difference is voluntarily referred by the parties. ARBITRARY, that which is left to the choice or arbitration of men, or not fixed by any positive law or jurisdiction. ARBITRARY *punishment*, in Scots law, denotes such punishments as are by statute left to the discretion of the judge. It is a general rule in arbitrary punishments, that the judge cannot inflict death. Hence all punishments that are not capital have acquired the name of arbitrary punishments, even although they be expressly pointed out by statute. ARBITRATION, ARBITRAGE, or ARBITREMENT, the power given by contending parties to an arbiter. See *ARBITER*. ARBITRATOR, a private extraordinary judge, chosen by the mutual consent of parties, to determine controversies between them. ARBOIS, a town of Franch Compe in France, situated in 5° 40' E. long. and 46° 50' N. lat. ARBON, a town of Swabia in Germany, situated in 9° 30' E. long. and 47° 40' N. lat. ARBOR, in mechanics, the principal part of a screw which serves to sustain the rest: also the axis or spindle on which a machine turns, as the arbor of a crane, windmill, &c.

ARBO-

**ARBORIST**, a person skilled in that part of botany which treats of trees.

**ARBOUR**, in gardening, a kind of shady bower, formerly in great esteem, but of late rejected, on account of its being damp and unwholesome.

Arbours are generally made of lattice-work, either of wood or iron, and covered with elms, limes, horn-beams; or with creepers, as honey-suckles, jasmynes, or passion-flowers; either of which will answer the purpose very well, if rightly managed.

**ARBUTUS**, in botany, a genus of the decandria monogynia class. The calix of the arbutus is divided into five parts; the corolla is ovated; the fruit is a berry with five partitions or cells. There are five species of arbutus, *viz.* the unedo, or common strawberry-tree, a native of Britain; the andrachne, a native of the East Indies; the acadensis, a native of Acadia; the alpina, or mountain strawberry-tree, a native of Britain; and the uva ursi, a plant lately discovered in the Highlands of Scotland, and which formerly was thought not to be a native of Britain.

**ARC, ARK, or ARCH.** See **ARCH.**

**ARCA cordis**, the same with pericardium. See **PERICARDIUM.**

**ARCADIA**, a sea-port town of European Turkey, situated on the western coast of the Morea, in 22° E. long. and 37° 20' N. lat.

**ARCANGIS**, in the Turkish armies, a kind of irregular light-armed horse which subsist by plunder.

**ARCANUM**, among physicians, any remedy, the preparation of which is industriously concealed, in order to enhance its value.

**ARCBOUTANT**, in building, an arched buttress. See **BUTTRESS.**

**ARCH**, in geometry; any part of the circumference of a circle or curved line, lying from one point to another, by which the quantity of the whole circle or line, or some other thing sought after, may be gathered. See **GEOMETRY.**

**ARCH**, in architecture, a concave building erected for the purposes of supporting some structure, or for making an easy passage over rivers. See **ARCHITECTURE.**

**Triumphal ARCH**, a stately gate of a semicircular form, adorned with sculpture, inscriptions, &c. erected in honour of those who had deserved a triumph.

**ARCH**, in composition, signifies chief, or of the first class, as archangel, archbishop, &c.

**ARCHÆUS, or ARCHEUS.** See **ARCHEUS.**

**ARCHANGEL**, an angel occupying the eighth rank in the celestial hierarchy.

**ARCHANGEL**, in botany. See **LAMIUM.**

**ARCHANGEL**, in geography, a city of the province of Dwina in Russia, situated four miles from the White Sea, in 40° 12' E. long. and 64° 30' N. lat.

**ARCHBISHOP**, a prelate who has several suffragan bishops under him. There are only two archbishops in England; the archbishop of Canterbury, who is primate of all England; and the archbishop of York, who is only styled primate of England.

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**ARCHBISHOPRIC**, in ecclesiastical geography, a province subject to the jurisdiction of an archbishop.

**ARCHBUTLER**, one of the great officers of the German empire, who presents the cup to the emperor on solemn occasions. This office belongs to the king of Bohemia.

**ARCHCHAMBERLAIN**, an officer of the empire, much the same with the great chamberlain in England. The elector of Brandenburg was appointed, by the golden bull, archchamberlain of the empire.

**ARCHCHANCELLOR**, an high officer who, in ancient times, presided over the secretaries of the court. Under the two first races of the kings of France, when their territories were divided into Germany, Italy, and Arles, there were three archchancellors: and hence the three archchancellors still subsisting in Germany; the archbishop of Mentz being archchancellor of Germany, the archbishop of Cologne of Italy, and the archbishop of Treves of Arles.

**ARCHCHANTOR**, the president of the chantors of a church.

**ARCHCOUNT**, a title formerly given to the earl of Flanders.

**ARCHDEACON**, an ecclesiastical dignitary or officer next to a bishop, whose jurisdiction extends either over the whole diocese, or only a part of it. There are 60 archdeacons in England, who visit the parishes subject to their jurisdiction, inquire into abuses, suspend, excommunicate, &c. They likewise induct all clerks into their benefices.

**ARCHDUKE**, a title given to dukes of greater authority and power than other dukes. The archduke of Austria is among the most ancient: His principal privileges are, that he shall distribute justice in his own country, without appeal; that he cannot be deprived of his countries, even by the emperor and the states of the empire; and that he have a power of creating counts, barons, &c. throughout the whole empire.

**ARCHED**, in a general sense, denotes something built or constructed in the fashion or after the manner of an arch.

**ARCHED legs**, a fault in a horse when his legs are bended archwise.

**ARCHER**, in the ancient military art, one who fought with bow and arrows. The English archers were esteemed the best in Europe, to whose prowess and dexterity the many victories over the French were in a great measure owing.

**ARCHES-court**, the chief and most ancient consistory that belongs to the archbishop of Canterbury, for the debating of spiritual causes, so called from Bow-Church in London, where it is kept, whose top is raised of stone-pillars, built archwise. The judge of this court is termed the dean of the arches, or official of the arches-court: Dean of the arches, because with this office is commonly joined a peculiar jurisdiction of thirteen parishes in London, termed a deanry, being exempted from the authority of the bishop of London, and belonging to the archbishop of Canterbury; of which the parish of Bow is one. Some others

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thers say, that he was first called dean of the arches, because the official to the archbishop, the dean of the arches, was his substitute in his court; and by that means the names became confounded. The jurisdiction of this judge is ordinary, and extends through the whole province of Canterbury; so that, upon any appeal, he forthwith, and without any further examination of the cause, sends out his citation to the party appealed, and his inhibition to the judge from whom the appeal is made.

**ARCHES**, in geography, a name used among navigators for the Archipelago.

**ARCHETYPE**, the first model of a work, which is copied after to make another like it. Among minters, it is used for the standard weight by which the others are adjusted. The archetypal world, among Plato-

nists, means the world as it existed in the idea of God, before the visible creation.

**ARCHEUS**, among chemists, a term used to denote the predominating principle of things, whereby their peculiar qualities are fixed and determined.

**ARCHILOCHIAN**, a term in poetry, applied to a sort of verses, of which Archilochus was the inventor, consisting of seven feet, the four first whereof are ordinarily dactyls, though sometimes spondees, the three last trochees; as in Horace,

*Solvitur acris hyems, gratâ vice veris & Favoni.*

**ARCHIPELAGO**, in geography, a general term for a sea interrupted with islands; but more especially denoting that between Greece and Asia.

**ARCHITECT**, a person skilled in architecture.

## ARCHITECTURE.

**ARCHITECTURE**, or the art of building, ought to be considered in a twofold light, as an object of taste, and as a mechanical art. An examination of its principles improves our taste; the practical part contains

such instructions as are necessary for the mechanic. Many books have been composed upon the mechanical part, but few authors have attempted to unfold the philosophical principles of the art.

### S E C T. I.

#### OF ARCHITECTURE AS AN OBJECT OF TASTE.

**M**ANY ages must have elapsed before architecture came to be considered as a fine art. Utility was its original destination, and still continues to be its principal end. Experience, however, has taught us, that architecture is capable of exciting a variety of agreeable feelings. Of these, utility, grandeur, regularity, order, and proportion, are the chief.

Architecture being an useful as well as a fine art, leads us to distinguish buildings, and parts of buildings, into three kinds, *viz.* what are intended for use solely, what for ornament solely, and what for both. Buildings intended for utility solely, ought in every part to correspond precisely to that intention: The least deviation from use, though contributing to ornament, will be disagreeable; for every work of use being considered as a mean to an end, its perfection as a mean is the capital circumstance, and every other beauty in opposition is neglected as improper. On the other hand, in such things as are intended solely for ornament, as columns, obelisks, triumphal arches, &c. beauty alone ought to be regarded. The principal difficulty in architecture lies in combining use and ornament. In order to accomplish these ends, different and even opposite means must be employed; which is the reason why they are so seldom united

in perfection; and hence, in buildings of this kind, the only practicable method is, to prefer utility to ornament according to the character of the building: In palaces, and such buildings as admit of a variety of useful contrivance, regularity ought to be preferred; but in dwelling-houses that are too small for variety of contrivance, utility ought to prevail, neglecting regularity as far as it stands in opposition to convenience.

In considering attentively the beauty of visible objects, we discover two kinds. The first may be termed *intrinsic* beauty, because it is discovered in a single object, without relation to any other. The second may be termed *relative* beauty, being founded on a combination of relative objects. Architecture admits of both kinds. We shall first give a few examples of *relative* beauty.

The proportions of a door are determined by the use to which it is destined. The door of a dwelling-house, which ought to correspond to the human size, is confined to seven or eight feet in height, and three or four in breadth: The proportions proper for a stable or coach-house are different. The door of a church ought to be wide, in order to afford an easy passage for a multitude; and its height must be regulated by its wideness, that the proportion may please the eye. The size of the windows



dows ought always to be proportioned to that of the room they are destined to illuminate; for if the apertures be not large enough to convey light to every corner, the room must be unequally lighted, which is a great deformity. Steps of stairs should likewise be accommodated to the human figure, without regarding any other proportion; they are accordingly the same in large and in small buildings, because both are inhabited by men of the same size.

We shall next consider *intrinsic* beauty, blended with that which is *relative*. A cube in itself is more agreeable than a parallelepipedon; this constantly holds in small figures: But a large building in the form of a cube is lumpish and heavy; while a parallelepipedon, set on its smaller base, is more agreeable on account of its elevation: Hence the beauty of Gothic towers. But if this figure were to be used in a dwelling-house, to make way for relative beauty, we would immediately perceive that utility ought chiefly to be regarded; and this figure, inconvenient by its height, ought to be set on its larger base: The loftiness in this case would be lost; but that loss will be more than sufficiently compensated by the additional convenience. Hence the form of buildings spread more upon the ground than raised in height, is always preferred for a dwelling-house.

With regard to the internal divisions, utility requires that the rooms be rectangular, to avoid useless spaces. An hexagonal figure leaves no void spaces; but it determines the rooms to be all of one size, which is both inconvenient and disagreeable for want of variety. Tho' a cube be the most agreeable figure, and may answer for a room of a moderate size; yet, in a very large room, utility requires a different figure. Unconfined motion is the chief convenience of a great room; to obtain this, the greatest length that can be had is necessary. But a square room of a large size is inconvenient. It removes chairs, tables, &c. at too great a distance from the hand, which, when unemployed, must be ranged along the sides of the room. Utility therefore requires a large room to be a parallelogram. This figure is likewise best calculated for the admission of light; because, to avoid cross-lights, all the windows ought to be in one wall; and if the opposite wall be at such a distance as not to be fully lighted, the room must be obscure. The height of a room exceeding nine or ten feet, has little relation to utility; therefore proportion is the only rule for determining the height, when above that number of feet.

Artists who deal in the beautiful, love to entertain the eye; palaces and sumptuous buildings, in which intrinsic beauty may be fully displayed, give them an opportunity of exerting their taste. But such a propensity is peculiarly unhappy with regard to private dwelling-houses; because in these, relative beauty cannot be displayed to perfection, without hurting intrinsic beauty. There is no opportunity for great variety of form in a small house; and in edifices of this kind, internal convenience has not hitherto been happily adjusted to external regularity. Perhaps an accurate coincidence in this respect is beyond the reach of art. Architects, however, constantly split upon this rock; for they never can be persuaded to give over attempting to reconcile these two incompatibles:

How otherwise should it happen, that of the endless variety of private dwelling-houses, there should not be one found that is generally agreed upon as a good pattern? The unwearied propensity to make a house regular as well as convenient, obliges the architect, in some articles, to sacrifice convenience to regularity, and, in others, regularity to convenience; and accordingly the house, which turns out neither regular nor convenient, never fails to displease.

Nothing can be more evident, than that the form of a dwelling-house ought to be suited to the climate; yet no error is more common than to copy in Britain the form of Italian houses, not forgetting even those parts that are purposely contrived for collecting air, and for excluding the sun: Witness our colonnades and loggias, designed by the Italians to gather cool air, and exclude the beams of the sun, conveniences which the climate of this country does not require.

We shall next view architecture as one of the fine arts; which will lead us to the examination of such buildings, and parts of buildings, as are calculated solely to please the eye. Variety prevails in the works of nature; but art requires to be guided by rule and compass. Hence it is, that in such works of art as imitate nature, the great art is, to hide every appearance of art; which is done by avoiding regularity, and indulging variety. But in works of art that are original and not imitative, such as architecture, strict regularity and uniformity ought to be studied, so far as consistent with utility.

Proportion is not less agreeable than regularity and uniformity; and therefore, in buildings intended to please the eye, they are all equally essential. It is taken for granted by many writers, that in all the parts of a building there are certain strict proportions which please the eye, in the same manner as in sound there are certain strict proportions which please the ear; and that, in both, the slightest deviation is equally disagreeable. Others seem to relish more a comparison between proportion in numbers, and proportion in quantity; and maintain, that the same proportions are agreeable in both. The proportions, for example, of the numbers 16, 24, and 36, are agreeable; and so, say they, are the proportions of a room, whose height is 16 feet, the breadth 24, and the length 36. But it ought to be considered, that there is no resemblance or relation between the objects of different senses. What pleases the ear in harmony, is not the proportion of the strings of the instrument, but of the sound which these strings produce. In architecture, on the contrary, it is the proportion of different quantities that pleases the eye, without the least relation to sound. The same thing may be said of numbers. Quantity is a real quality of every body; number is not a real quality, but merely an idea that arises upon viewing a plurality of things in succession. An arithmetical proportion is agreeable in numbers; but have we from this any reason to conclude, that it must also be agreeable in quantity? At this rate, a geometrical proportion, and many others, ought also to be agreeable in both. A certain proportion may coincide in quantity and number; and amongst an endless variety of proportions, it would be wonderful if there never should be a coincidence.

coincidence. One example is given of this coincidence, in the numbers 16, 24, and 36; but to be convinced that it is merely accidental, we need but reflect, that the same proportions are not applicable to the external figure of a house, and far less to a column.

It is ludicrous to observe writers acknowledging the necessity of accurate proportions, and yet differing widely about them. Laying aside reasoning and philosophy, one fact universally agreed on ought to have undeceived them, that the same proportions which please in a model are not agreeable in a large building: A room 48 feet in length, and 24 in breadth and height, is well proportioned; but a room 12 feet wide and high, and 24 long, approaches to a gallery.

Ferrault, in his comparison of the ancients and moderns, goes to the opposite extreme, maintaining, that the different proportions assigned to each order of columns are arbitrary, and that the beauty of these proportions is entirely the effect of custom. But he should have considered, that if these proportions had not originally been agreeable, they could never have been established by custom.

For illustrating this point, we shall add a few examples of the agreeableness of different proportions. In a sumptuous edifice, the capital rooms ought to be large, otherwise they will not be proportioned to the size of the building; for the same reason, a very large room is improper in a small house. But in things thus related, the mind requires not a precise or single proportion, rejecting all others; on the contrary, many different proportions are equally agreeable. It is only when a proportion becomes loose and distant, that the agreeableness abates, and at last vanishes. Accordingly, in buildings, rooms of different proportions are found to be equally agreeable, even where the proportion is not influenced by utility. With regard to the proportion the height of a room should bear to the length and breadth, it must be extremely arbitrary, considering the uncertainty of the eye as to the height of a room when it exceeds 16 or 17 feet. In columns, again, every architect must confess, that the proportion of height and thickness varies betwixt 8 diameters and 10, and that every proportion between these two extremes is agreeable. Besides, there must certainly be a further variation of proportion, depending on the size of the column: A row of columns 10 feet high, and a row twice that height, requires different proportions: The intercolumniations must also differ in proportion according to the height of the row.

Proportion of parts is not only itself a beauty, but is inseparably connected with a beauty of the highest relish, that of concord and harmony; which will be plain from what follows: A room, the parts of which are all finely adjusted to each other, strikes us not only with the beauty of proportion, but with a pleasure far superior. The length, the breadth, the height, the windows, raise each of them a separate emotion: These emotions are similar; and, though faint when separately felt, they produce, in conjunction, the emotion of concord or harmony, which is very pleasant. On the other hand, where the length of a room far exceeds the breadth, the mind, comparing together parts so intimately connected, immediately per-

ceives a disagreement or disproportion which disgusts. Hence a long gallery, however convenient for exercise, is not an agreeable figure of a room.

In buildings destined chiefly or solely to please the eye, regularity and proportion are essentially necessary, because they are the means of producing intrinsic beauty. But a skilful artist will not confine his view to regularity and proportion; he will also study congruity, which is perceived when the form and ornaments of a structure are suited to the purpose for which it is appointed. Hence every building ought to have an expression suited to its destination. A palace ought to be sumptuous and grand; a private dwelling, neat and modest; a play-house, gay and splendid; and a monument, gloomy and melancholy. A heathen temple has a double destination: It is considered as a house dedicated to some divinity; therefore it ought to be grand, elevated, and magnificent: It is also considered as a place of worship; and therefore ought to be somewhat dark and gloomy, because dimness or obscurity produces that tone of mind which is favourable to humility and devotion. Columns, besides their chief destination of being supports, contribute to that peculiar expression which the destination of a building requires: Columns of different proportions serve to express loftiness, lightness, &c. as well as strength. Situation may also contribute to expression: Conveniency regulates the situation of a private dwelling-house; and the situation of a palace ought to be lofty. This leads to a question, Whether the situation, where there happens to be no choice, ought, in any measure, to regulate the form of the edifice? The connection between a great house and a neighbouring field, though not extremely intimate, demands however some congruity. It would, for example, displease us to find an elegant building thrown away upon a wild uncultivated country: Congruity requires a polished field for such a building. The old Gothic form of building was well suited to the rough uncultivated regions where it was invented; but was very ill adapted to the fine plains of France and Italy.

The external structure of a house leads naturally to its internal structure. A large and spacious room, which is the first that commonly receives us, is a bad contrivance in several respects. In the first place, when immediately from the open air we step into such a room, its size in appearance is diminished by contrast; it looks little, compared with the great canopy of the sky. In the next place, when it recovers its grandeur, as it soon doth, it gives a diminutive appearance to the rest of the house; passing from it, every apartment looks little. In the third place, by its situation it serves only for a waiting-room, and a passage to the principal apartments. Rejecting therefore this form, a hint may be taken from the climax in writing for another that appears more suitable: A handsome portico, proportioned to the size and fashion of the front, leads into a waiting-room of a larger size, and this to the great room, all by a progression from small to great.

Grandeur is the principal emotion that architecture is capable of raising in the mind: it might therefore be the chief study of the artist, in great buildings destined

to please the eye. But as grandeur depends partly on size, it is unlucky for architecture that it is governed by regularity and proportion, which never deceive the eye by making objects appear larger than they are in reality. But though regularity and proportion contribute nothing to grandeur, so far as that emotion depends on size; yet they contribute greatly to it by confining the size within such bounds that it can be taken in and examined at one view; for, when objects are so large as not to be comprehended but in parts, they tend rather to distract than satisfy the mind.

We shall next pass to such ornaments as contribute to give buildings a peculiar expression. It has been doubted, whether a building can regularly admit any ornament but what is useful, or at least has that appearance. But, considering the double aim of architecture as a fine, as well as an useful art, there is no reason why ornaments may not be added to please the eye, without any relation to utility. A private dwelling-house, it is true, and other edifices, where use is the chief aim, admit not regularly any ornament but what has at least the appearance of use: But temples, triumphal arches, and other buildings intended chiefly or solely for show, may be highly ornamented.

This suggests a division of ornaments into three kinds, viz. 1. Ornaments that are beautiful without relation to use; such as statues, vases, basso or alto relievo: 2. Things in themselves not beautiful, but possessing the beauty of utility, by imposing on the spectator, and appearing to be useful; such as blind windows: 3. Where things are beautiful in themselves, and at the same time take on the appearance of use; such as pilasters.

With regard to the *first*, we naturally require that a statue be so placed, as to be seen in every direction, and examined at different distances. Statues, therefore, are properly introduced to adorn the great stair that leads to the principal door of a palace, or to lessen the void between pillars. But a niche in the external front is an improper place for a statue. There is an additional reason against placing them upon the roof or top of the walls; their ticklish situation gives pain, as they have the appearance of being in danger of tumbling down; besides, we are inclined to feel from their being too much exposed to the inclemencies of the weather. To adorn the top of the wall with a row of vases, is an unhappy conceit, by placing a thing, whose natural destination is utility, where it cannot have even the appearance of use. As to carvings upon the external surface of a building, termed *basso relievo* when flat, and *alto relievo* when prominent, all contradictory expressions ought to be avoided. Now, firmness and solidity being the proper expressions of a pedestal, and, on the contrary, lightness and delicacy of carved work, the pedestal, whether of a column or of a statue, ought to be sparingly ornamented. The ancients never ventured any bolder ornament than the *basso relievo*.

With respect to ornaments of the *second* kind, it is a great blunder to contrive them so as to make them appear useless. A blind window, therefore, when necessary for regularity, ought to be so disguised as to appear a real window: When it appears without disguise, it is disgust-

ful, as a vain attempt to supply the want of invention; it shows the irregularity in a stronger light, by signifying that a window ought to be there in point of regularity, but that the architect had not skill sufficient to connect external regularity with internal convenience.

As to the *third*, it is an error to sink pilasters so far into the wall, as to remove totally, or mostly, the appearance of use. They should always project so much from the wall, as to have the appearance of supporting the entablature over them.

From ornaments in general, we descend to a pillar, the chief ornament in great buildings. The destination of a pillar is to support, really or in appearance, another part termed the *entablature*. With regard to the form of a pillar, it must be observed, that a circle is a more agreeable figure than a square, a globe than a cube, and a cylinder than a parallelepipedon. This last, in the language of architecture, is saying, that a column is a more agreeable figure than a pilaster; and for that reason it ought to be preferred, when all other circumstances are equal. Another reason concurs, that a column annexed to a wall, which is a plain surface, makes a greater variety than a pilaster. Besides, pilasters at a distance are apt to be mistaken for pillars; and the spectator is disappointed when, on a nearer approach, he discovers them to be only pilasters.

As to the parts of a column, a bare uniform cylinder, without a capital, appears naked; and without a base, appears too ticklishly placed to stand firm: It ought therefore to have some finishing at the top and bottom: Hence the three chief parts of a column, the shaft, the base, and the capital. Nature undoubtedly requires proportion among these parts, but it admits of variety of proportion. Vitruvius and some of the elder writers seem to think, that the proportions of columns were derived from the human figure, the capital representing the head, the base the feet, and the shaft the body. The Tuscan has been accordingly denominated the *Gigantic*; the Doric, the *Herculean*; the Ionic, the *Matronal*; and the Corinthian, the *Virginal*:—the Composite is a mixture of the Corinthian and Ionic. As to the base, the principle of utility interposes to vary it from the human figure, and to proportion it so to the whole, as to give the column the appearance of stability.

Among the Greeks, we find only three orders of columns, the Doric, the Ionic, and the Corinthian, distinguished from each other by their destination as well as by their ornaments. It has been disputed, whether any new order can be added to these: Some hold the affirmative, and give for instances the Tuscan and Composite; others maintain, that these properly are not distinct orders, but only the original orders with some slight variation. The only circumstances that can serve to distinguish one order from another, are the form of the column, and its destination. To make the first a distinguishing mark without regard to the other, would multiply orders without end. Destination is more limited, and it leads us to distinguish three kinds of orders; one plain and strong, for the purpose of supporting plain and massy buildings; one delicate and graceful, for supporting buildings of that character; and between these, a

third, supporting buildings of a mixed nature. So that, if destination alone is to be regarded, the Tuscan is of the same order with the Doric, and the Composite with the Corinthian.

The ornaments of these three orders ought to be suited to the purposes for which they are intended. Plain and rustic ornaments would be not a little discordant with the elegance of the Corinthian order, and sweet and delicate ornaments not less with the strength of the Doric.

With respect to buildings of every kind, one rule, dictated by utility, is, that they be firm and stable. An-

other, dictated by beauty, is, that they ~~also~~ appear so to the eye; for every thing that appears tottering, and in hazard of tumbling down, produceth in the spectator the painful emotion of fear, instead of the pleasing emotion of beauty; and accordingly it should be the great care of the artist, that every part of his edifice appear to be well supported. Some have introduced a kind of conceit in architecture, by giving parts of buildings the appearance of falling; of this kind is the church of St Sophia in Constantinople; the round towers in the uppermost stories of Gothic buildings is in the same false taste.

## S E C T. II.

### OF ARCHITECTURE AS A MECHANICAL ART.

#### *Of the ORIGIN of BUILDINGS.*

**B**UILDINGS, in the first ages of society, behoved to be extremely rude. The first huts were probably of a conic figure, being the most simple, and best adapted to the materials that could be obtained in such an uncultivated state of society. These huts were formed of branches of trees, covered with reeds, leaves, and clay.

But, finding the conic figure inconvenient, on account of its inclined sides, they changed it into a cubical one, in the following manner: They fixed in the ground several upright trees to form the sides, filling the intervals between them with branches closely interwoven, and covered with clay. The sides being thus complicated, four large beams were placed on the upright trunks, which, being well joined at the angles, kept the sides firm; and likewise served to support the roof, which was composed of many joists, covered with reeds, leaves, and clay.

As men improved in the art of building, new methods of rendering their huts lasting and handsome were gradually invented. They took off the bark and other unevennesses from the trunks of the trees that formed the sides, and raised them above the dirt on stones. The spaces between the ends of the joists were closed with clay, and the ends of them were covered with thin boards, cut in the form of triglyphs, &c.

From this simple construction the different orders of architecture took their rise. When buildings of wood were laid aside, they imitated, in their edifices of stone, the form which necessity had introduced into the primitive huts: Hence the upright trees gave rise to the columns; and the beams, joists, rafters, and strata of materials that formed the covering, suggested architraves, friezes, triglyphs, and cornices.

At what time, or by whom, the Grecian orders were invented, is not certainly known. But the following is the account which Vitruvius gives of them.

Dorus, king of Achaia, and son of Helenes and Optica, built a temple to Juno in the ancient city of Argos, which happened to be in the manner now called *Doric*, from the name of the inventor. This manner was afterwards imitated in many other temples in the several cities of Achaia.

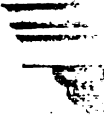
The Athenians, about the same time, sent thirteen colonies into Asia, under the command of Ion, son of Xanthus and Creusa. This Ion conquered all Caria, founded many cities, and called the country *Ionis*. The first temple he built was after the Doric manner. But afterwards he built a temple to Diana of a more delicate structure, and formed upon the proportions of a female body, as the Doric had been on those of a robust man. The capital was adorned with volutes, to represent the curls of a woman's hair; and flutings were cut on the shaft of the column, in imitation of the folds of her garment. This order got the name of *Ionic*, in honour of the Ionians who invented it.

The third sort of columns, called *Corinthian*, are said to owe their origin to the following accident:—A young girl of Corinth having died, her nurse placed on her tomb a basket, containing certain triquetras, in which she delighted when alive, and covered it with a tyle to prevent the rain from spoiling them. The basket happened to be placed on a root of acanthus, which pushing out its leaves in the spring, covered the sides of the basket; some of the longest of which, being obstructed by the corners of the tyle, were forced downwards, and curled in the manner of volutes. Calimachus the sculptor, passing near the tomb, was so pleased with the beautiful appearance of the acanthus growing in this manner, that he imitated it in the columns which he afterwards made at Corinth.

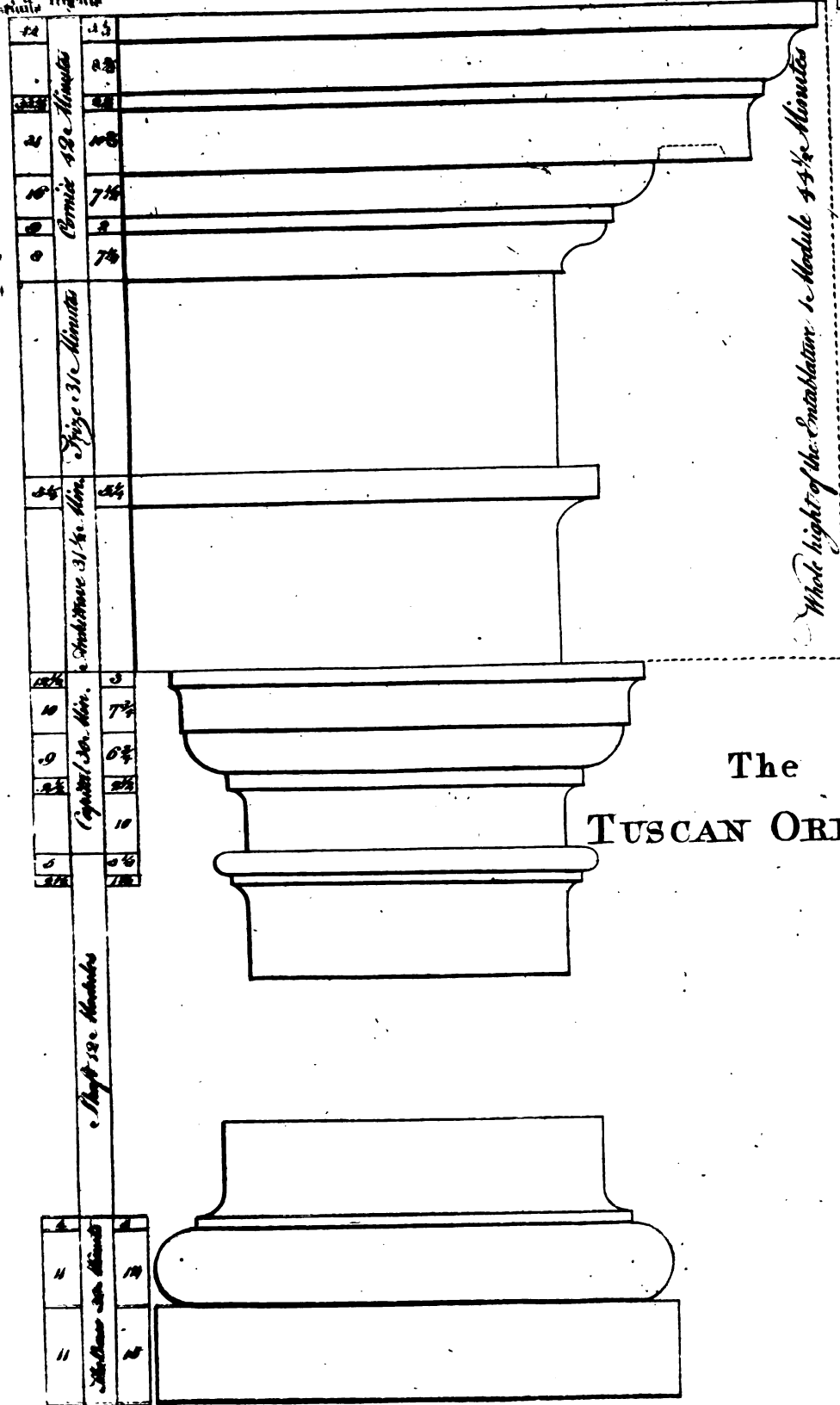
Villalpandus treats this story of Calimachus as a fable, and maintains that the Corinthian capital took its origin from an order in Solomon's temple; and it must be acknowledged, that some descriptions in the Bible favour this opinion.

Besides these three orders, said to be invented by the Greeks, two other, viz. the Tuscan and Composite, are thought to have been invented by the Romans. The Tuscan first appeared in Tuscany, before the Romans had any intercourse with the Greeks. The Composite is a mixture of the Ionic and Corinthian. These five manners of building, invented by the ancients, are called **ORDERS**, on account of the regularity and beauty of their forms.

of

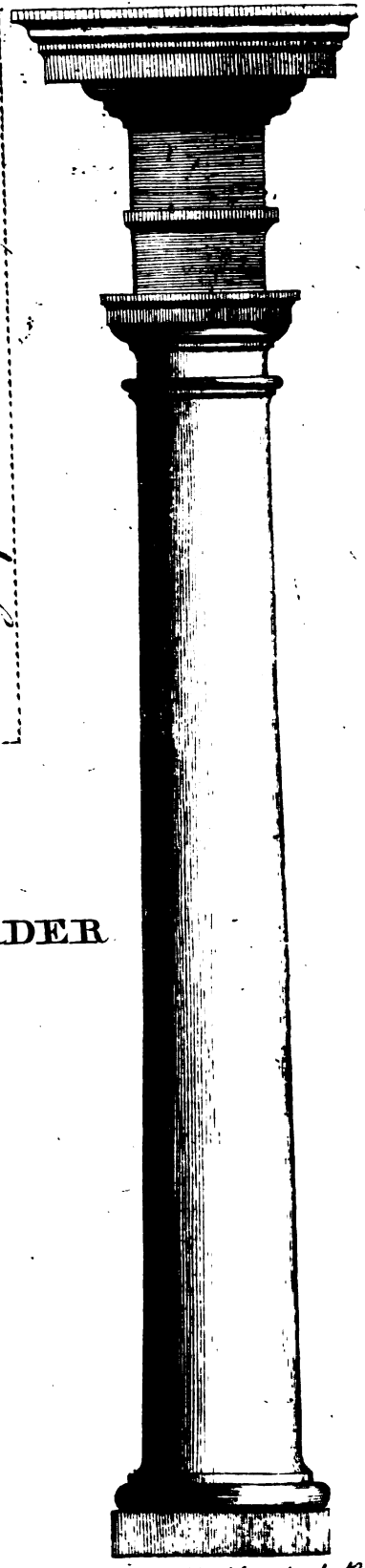


Height of Capital



Whole height of the Entablature is Module 44 1/2 Minutae

The TUSCAN ORDER.



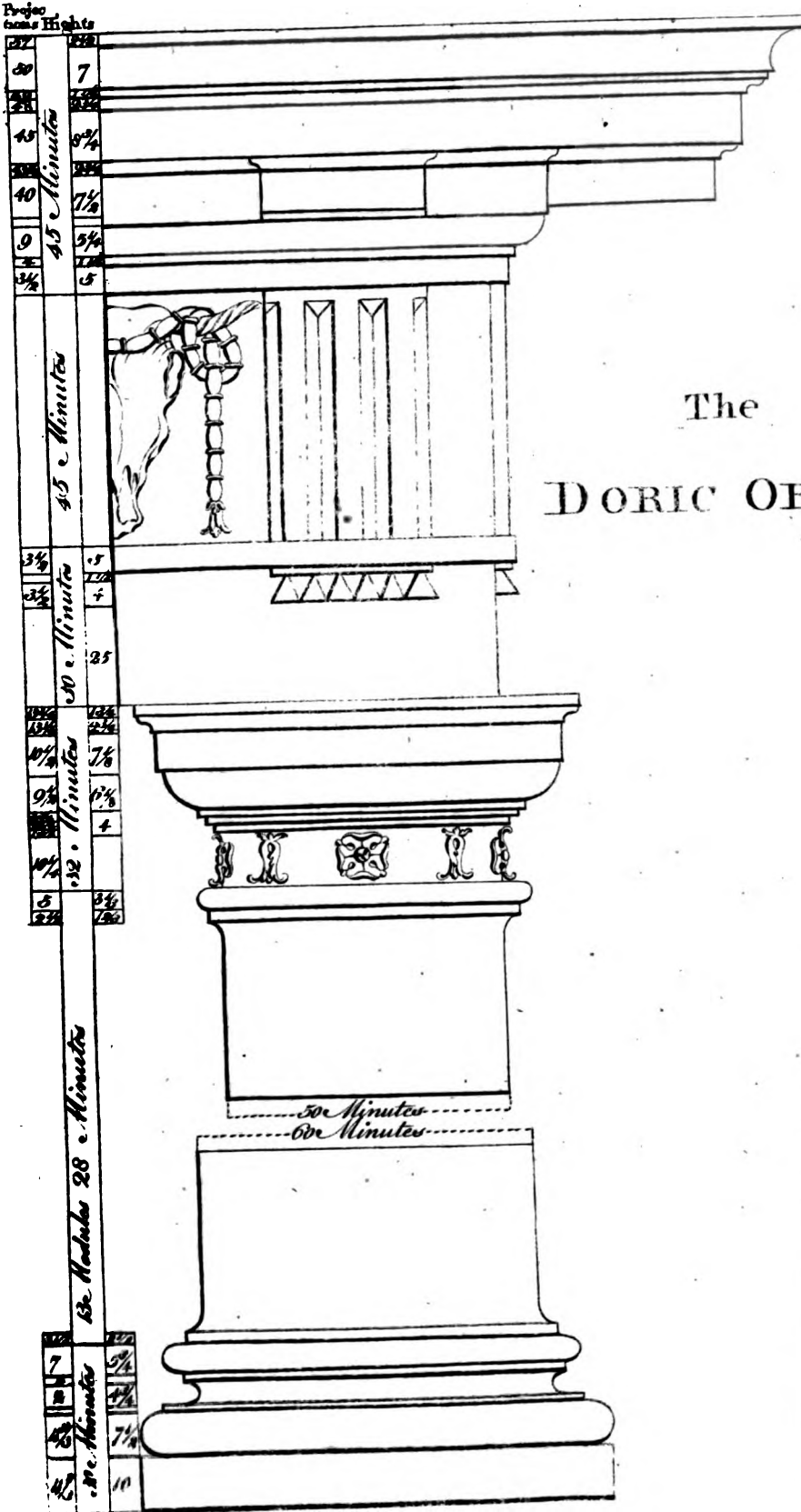
A. Bell Sculpt.

1875

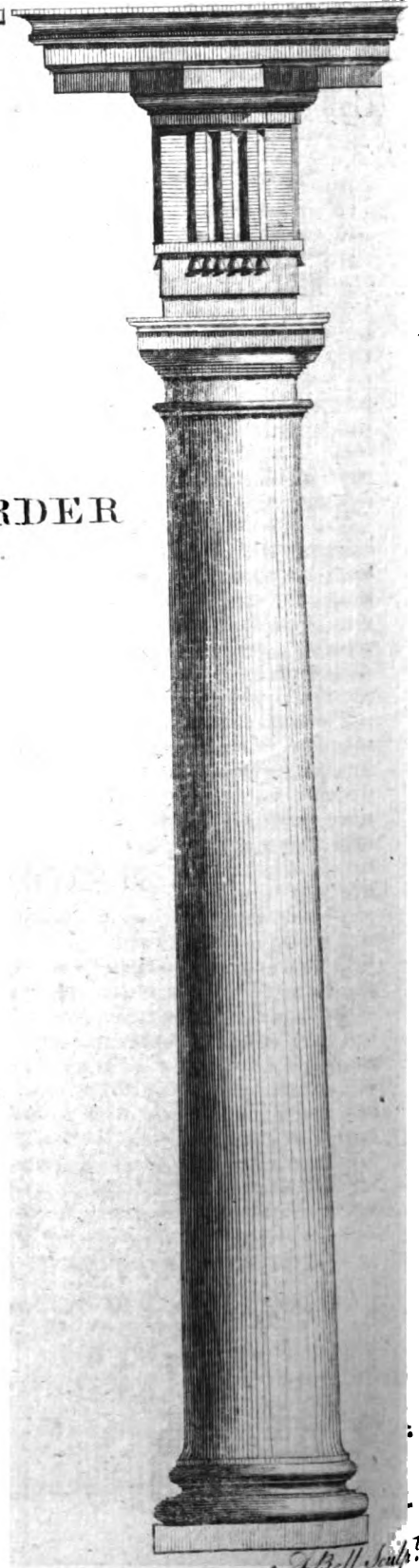
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1875



The DORIC ORDER



*Ad Bell. Sculp.*



*Of the PARTS that compose an ORDER, and their ORNAMENTS.*

THE parts that compose an order may be distributed into two different classes. In the *first* may be ranged all that have any analogy to the primitive huts, and represent some part that was necessary in their construction. Such are the shaft of the column, with the plinth of its base, and the abacus of its capital, representing the upright trees, with the stones on which they were placed, and those that covered them; likewise the architrave and triglyphs, representing the beams and joists; the mutules, modillions, or dentils, which all of them represent the rafters, or some other pieces of timber used to support the covering; and the corona, representing the beds of materials that composed the covering. All these may properly be distinguished by the name of essential members. The subservient parts, contrived for the use or ornament of the former, and commonly called mouldings, may constitute the *second* class.

THERE are eight regular mouldings in ornamenting columns; the fillet, listel, or square; the astragal, or bead; the torus, or torse; the scotia, mould, or easement; the echinus, ovolo, or quarter-round; the inverted cyma, talon, or ogee; the cyma, cyma recta, or synmatium; the cavetto, or hollow. The names of these allude to their forms, and their forms are adapted to the purposes for which they are intended. See Plate XXVII.

The ovolo and talon, as they are strong at the extremities, are fit for supports; the cyma and cavetto, tho' improper for supports, serve for coverings to shelter other members; the torus and astragal, being shaped like ropes, are intended to bind and fortify the parts with which they are connected. But the use of the scotia and fillet, is only to separate and distinguish the other mouldings, to give a graceful turn to the profile, and to prevent the confusion which would arise from joining several curved members together.

There are various methods of describing the contours of mouldings; but the simplest and best is to form them of quadrants of circles, as in Plate XXVII.

An assemblage of what are called essential parts and mouldings, is termed a *profile*. The most perfect profiles are such as are composed of few mouldings, varied in form and size; and so disposed, that the straight and curved ones succeed each other alternately. When ornaments are employed in mouldings, some of them should be left plain, in order to give a proper repose: For, when all are ornamented, the figure of the profile is lost.

*Of the ORDERS of ARCHITECTURE.*

AN ORDER consists of two principal members, the COLUMN and the ENTABLATURE; each of which is composed of three principal parts. Those of the Column are, the *Base*, the *Shaft*, and the *Capital*; and those of the Entablature are, the *Architrave*, the *Frize*, and the *Cornice*. All these are subdivided into many lesser parts, whose number, form, and dimensions characterize each order, and express the degree of strength, delicacy, richness, or simplicity peculiar to it.

I. OF THE TUSCAN.

THE TUSCAN (Plate XXIV.) is the most solid and simple of all the orders. It is composed of few parts, devoid of ornaments, and so massy, that it seems capable of supporting the heaviest burden. There are no remains of a regular Tuscan order among the antiques; the doctrine of Vitruvius concerning it is obscure; and the profiles of Palladio, Scamozzi, Serlio, de l'Orme, and Vignola, are all imperfect.

The height of the Tuscan column is 14 modules, or semidiameters, each consisting of 30 minutes; and that of the whole entablature  $3\frac{1}{2}$  modules; which being divided into 10 equal parts, three of them are for the height of the architrave, three for the freeze, and the remaining four for the cornice: The capital is one module; the base, including the lower cincture of the shaft, is likewise one module; and the shaft, with its upper cincture and astragal, 12 modules.

These are the general dimensions of the order; the particular dimensions may be learned by inspection of the plates.

In the remains of antiquity, the quantity of diminution at the top of the Tuscan column is various; but seldom less than one eighth, nor more than one sixth of the inferior diameter of the column. The last of these is generally preferred; and Chalmers and others make the same diminution in all columns, without regard to their order.

2. OF THE DORIC ORDER.

THE DORIC ORDER, (Plate XXV.) is next in strength to the Tuscan; and being of a grave, robust, and masculine aspect, is by Scamozzi called the Herculean. As it is the most ancient of all the orders, it retains more of the structure of the primitive huts than any of the rest; the triglyphs in its freeze representing the ends of the joists; and the mutules in its cornice, representing the rafters.

The height of the Doric column, including its capital and base, is 16 modules, and the height of the entablature four; the latter of which being divided into eight parts, two of them are for the architrave, three for the frize, and three for the cornice.

In most of the antiques, the Doric column is executed without a base. Vitruvius likewise makes it without one; the base, according to him, having been first employed in the Ionic order, in imitation of the sandal of a woman's foot. Scamozzi blames this practice, and most of the modern architects are of his opinion.

In the profile of the theatre of Marcellus, the frize is enriched with husks and roses; the architrave consists only of one fascia and a fillet; the drops are conical; the metope is enriched with a bull's skull, adorned with a garland of beads, in imitation of those on the temple of Jupiter Tonans at the foot of the Capitol. In some antique fragments, and in a great many modern buildings, the metopes are alternately adorned with ox-skulls and pateras. But they may be filled with any other ornaments; according to the destination of the building.

## 3. OF THE IONIC ORDER.

THE IONIC ORDER (Plate XXVI.) is of a more slender make than the Doric or Tuscan; its appearance is simple, yet graceful and majestic; its ornaments are few; so that it has been compared to a sedate matron, in decent, rather than magnificent attire.

Among the ancients, the form of the Ionic profile appears to have been more positively determined than that of any other order; for, in all the antiques at Rome, (the temple of Concord excepted) it is exactly the same.

The modern artists have likewise been unanimous in their opinions; all of them, excepting Palladio and his imitators, having employed the dentil, cornice, and the other parts of the profile, nearly as they are found in the Coliseum, the temple of Fortune, and the theatre of Marcellus.

The height of the Ionic column is 18 modules, and that of the entablature  $4\frac{1}{2}$ , or one quarter of the height of the column, as in the other orders, which is a trifle less than in any of the antique Ionics. In all the antiques, the base is Attic; and the shaft of the column may either be plain, or fluted with 24 flutings, or 20 only, as in the temple of Fortune. The plan of the flutings may be a trifle more than a semicircle, as in the forum of Nerva, because they then appear more distinct. The fillets, or intervals between them, must not be broader than one third of the breadth of a fluting, nor narrower than one fourth. The ornaments of the capital must correspond with the flutings of the shaft; and there must be an ove above the middle of each fluting. The volutes ought to be traced according to Mr Goldman's method, which is as follows:

Plate XXVII. fig. 9. Draw the cathetus FC, whose length must be 15 minutes, or one fourth of a module; and, from the point C, describe the eye of the volute AEBD, of which the diameter is to be  $6\frac{1}{2}$  minutes; divide it into four equal sectors by the diameters AB, DE. Bisect the radii CA, CB, in 1 and 4; and on the line 1, 4, construct a square 1, 2, 3, 4. From the centre C, to the angles 2, 3, draw the diagonals C2, C3; and divide the side of the square 1, 4, into 6 equal parts, at 5, 9, C, 12, 8. Then through the points 5, 9, 12, 8, draw the lines 5, 6, 9, 10, 12, 11, 8, 7, parallel to the diameter ED, which will cut the diagonals in 6, 7, 10, 11; and the points 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, will be the centres of the volute. From the first centre 1, with the distance 1F, describe the quadrant FG; from the second centre 2, with the distance 2G, describe the quadrant GH; and, continuing the same operation from all the 12 centres, the contour of the volute will be completed.

Fig. 10. The centres for describing the fillet are found in this manner. Construct a triangle, of which the side AF is equal to the part of the cathetus contained between AF and the side FV, equal to C1; place the distance FS from F towards A, equal to FS the breadth of the fillet, and through the point S draw the line ST, which will be to C1 in the same proportion as AS is to AF; place this line on the diameter of the eye AB;

divide it into three equal parts; and, through the points of division, draw lines parallel to the diameter ED, which will cut the diagonals C2, C3, and you will have twelve new centres, from whence the interior contour of the fillet may be described, in the same manner as the exterior one was from the first centres.

## 4. OF THE CORINTHIAN ORDER.

THE proportions of this order are extremely delicate. It is divided into a great variety of members, and enriched with a profusion of ornaments. Scamozzi calls it the *virginal order*; and indeed it has all the delicacy in its make, and all the gaiety in its dress, peculiar to young girls. See Plate XXVIII.

The most perfect model of the Corinthian order is generally allowed to be in the three columns in the Campo Vaccino at Rome, the remains, as it is thought, of the temple of Jupiter Stator.

The Corinthian column should be 20 modules high; and the entablature 5; which proportions are a medium between those of the Pantheon and the three columns. The base of the column may either be Attic or Corinthian: They are both beautiful. If the entablature be enriched, the shaft may be fluted. The flutings may be filled, to one third of their height, with cablings, as in the inside of the Pantheon; which will strengthen the lower part of the column, and make it less liable to injury.

In most of the antiques at Rome, the capital of this order is enriched with olive-leaves; the acanthus being seldom employed but in the Composite. De Cordemoy, however, prefers the acanthus.

The divisions of the entablature bear the same proportions to each other, as in the Tuscan, Ionic, and Composite orders.

## 5. OF THE COMPOSITE.

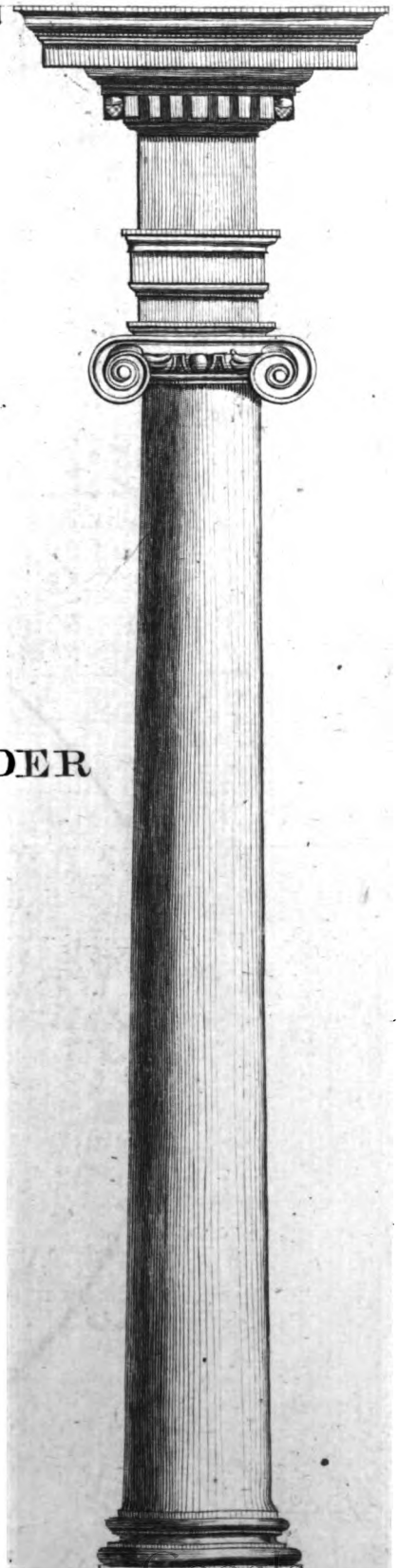
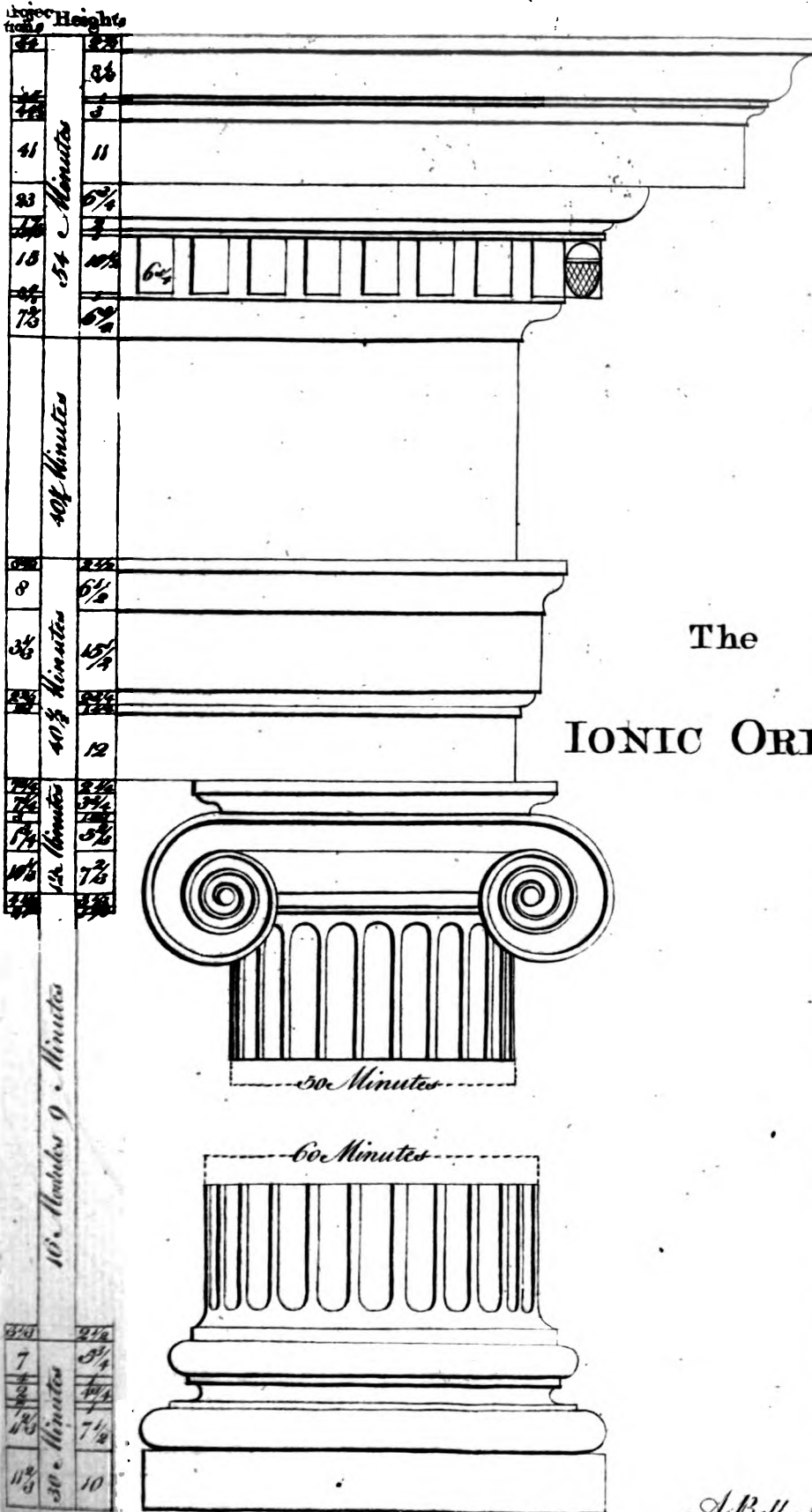
THE COMPOSITE is, strictly speaking, only a species of the Corinthian; and therefore retains, in a great measure, the same character. See Plate XXIX.

It does not appear that the ancients affected any particular form of entablature to this order. Sometimes the cornice is entirely plain, as in the temple of Bacchus; at others, as in the arch of Septimius Severus, it is enriched with dentils differing very little from the Ionic; and in the arch of Titus, there are both dentils and modillions; the whole form of the profile being the same with the Corinthian, as executed in the antiques at Rome.

The modern architects have varied more in this than in any other order, each following the bent of his own fancy.

The height of the Composite column, and parts of the entablature, is the same with that of the Corinthian. The foot of the leaves of the capital ought not to project beyond the upper part of the shaft. The different bunches of leaves should be strongly marked; the sprigs which arise between the upper ones should be kept flat upon the vase; and the ornaments of the volutes must not project beyond the fillets that inclose them.

D.F.



The  
**IONIC ORDER**



Fig. 1.  
Allet List

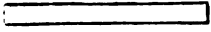


Fig. 2.  
Astragal

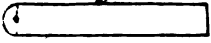


Fig. 3.  
Torus

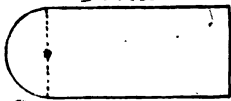


Fig. 4.  
Sotia Mouth



Fig. 5.  
Orvola

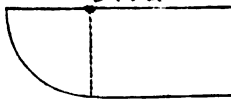


Fig. 6.  
Ogee

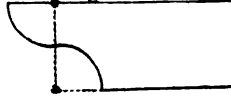


Fig. 7.  
Cyma Recta

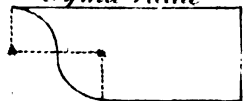


Fig. 8.  
Cavetto

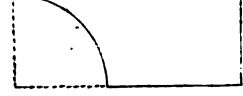


Fig. 9.  
VOLUTE

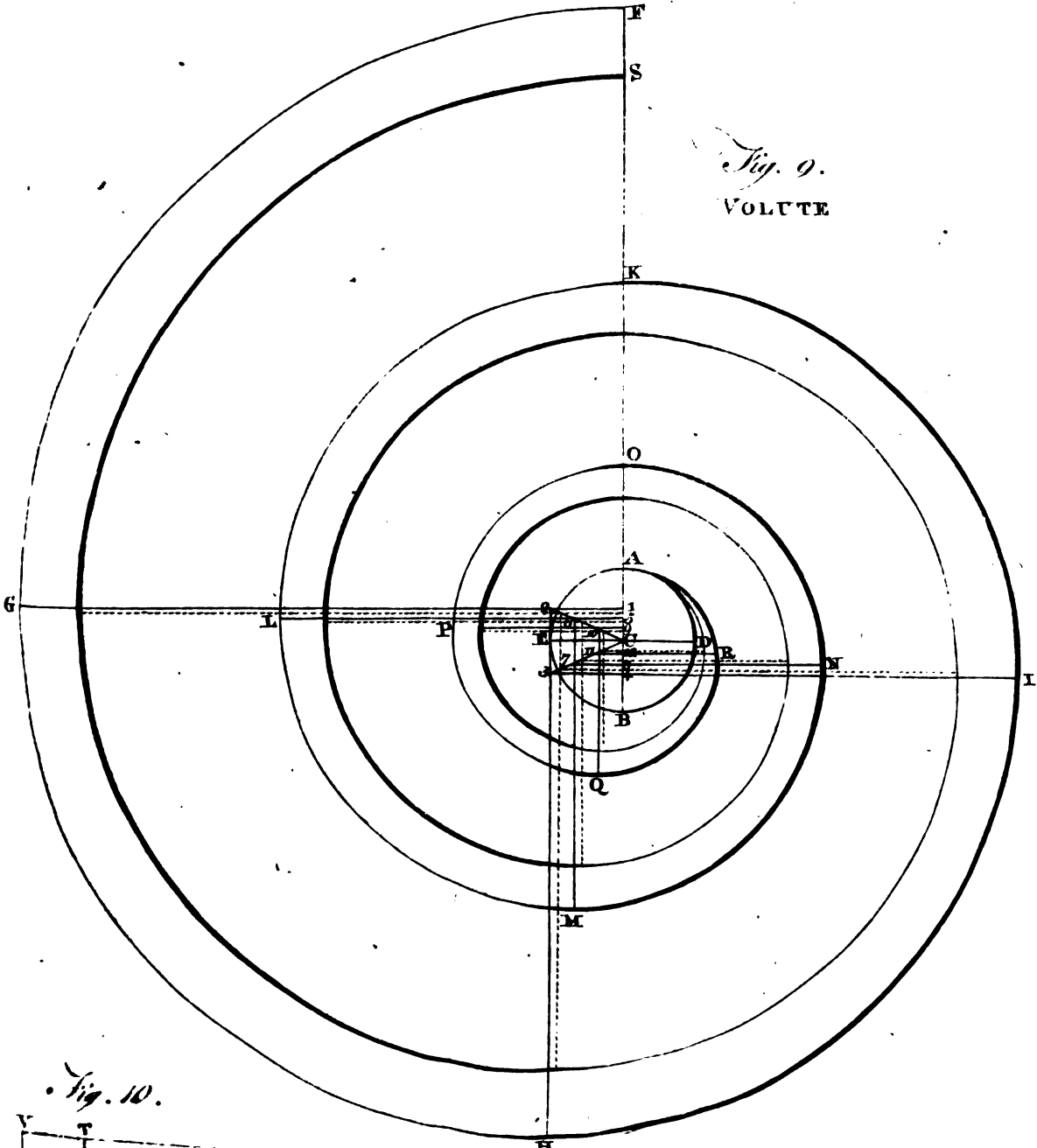
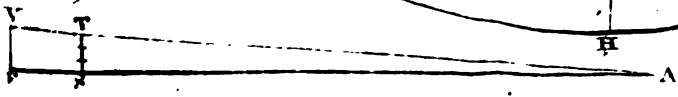
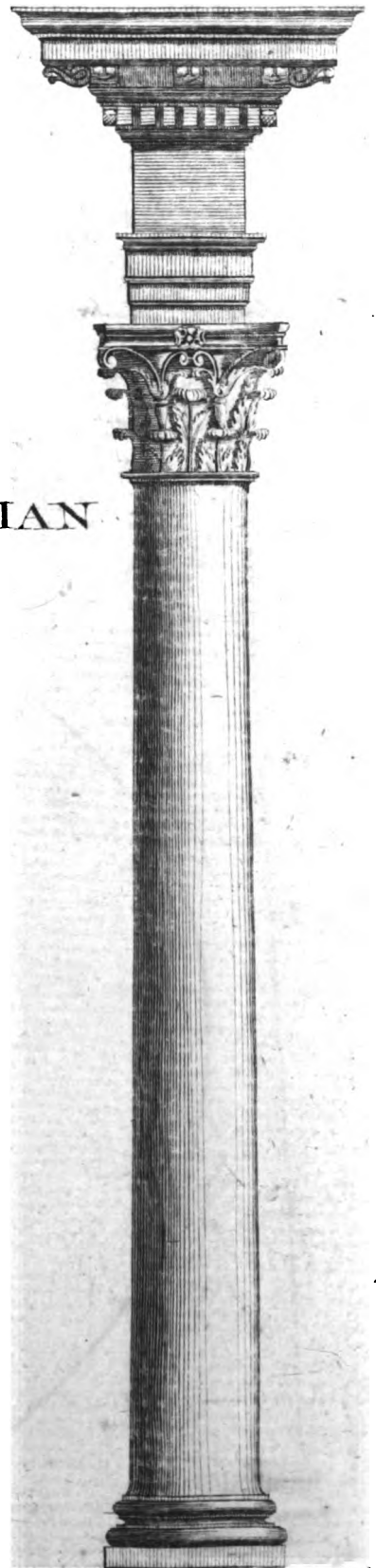
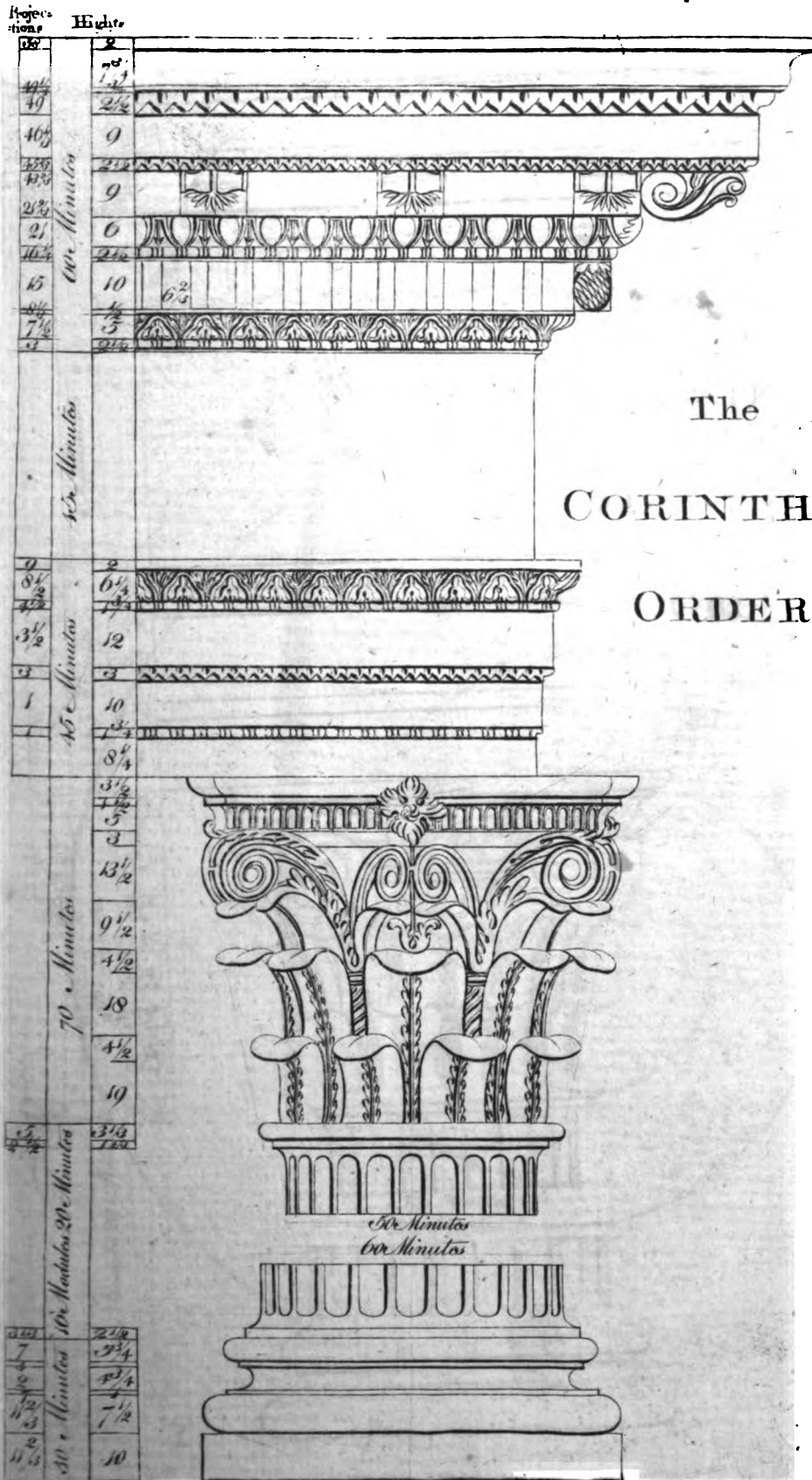


Fig. 10.





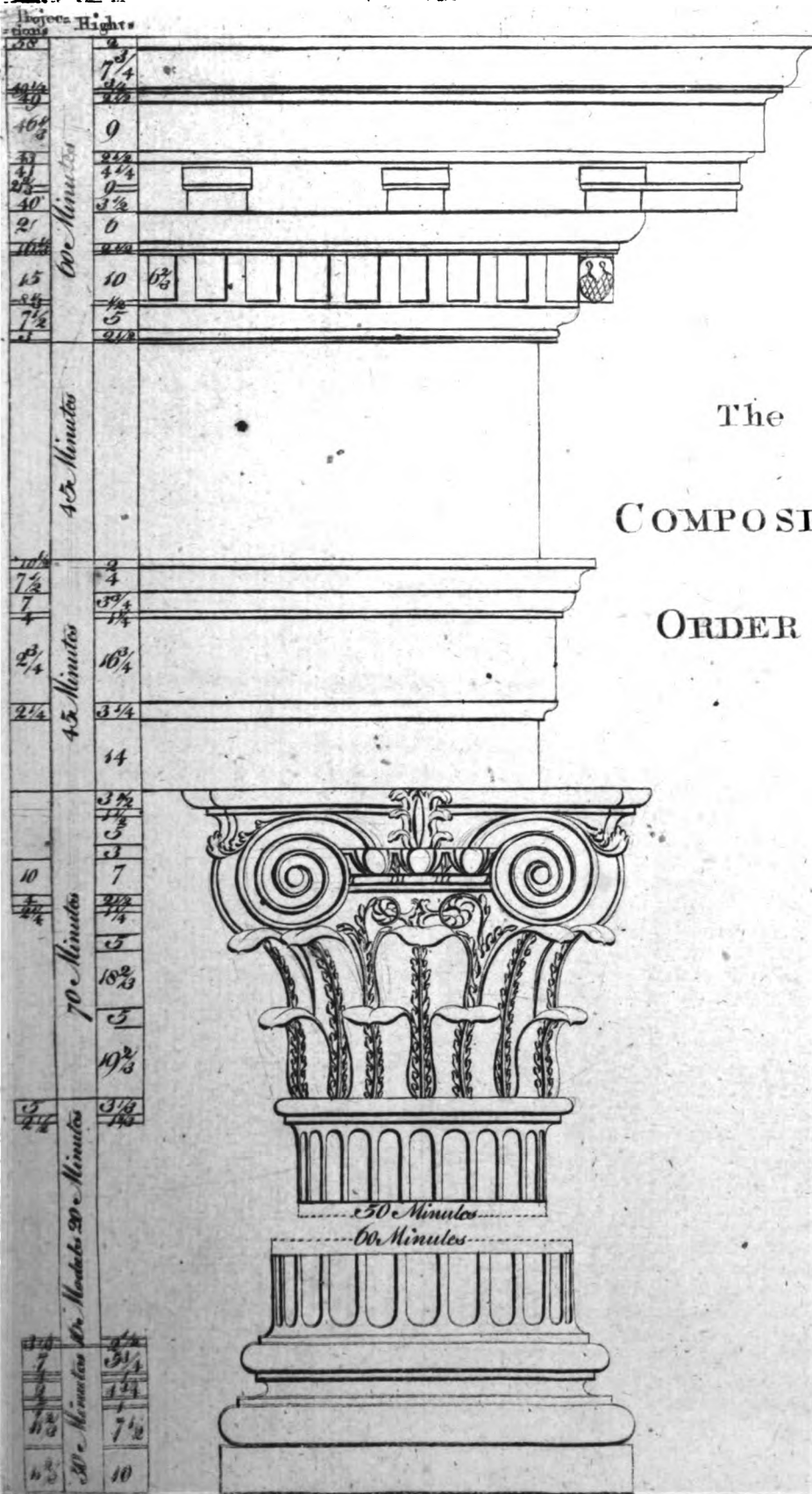
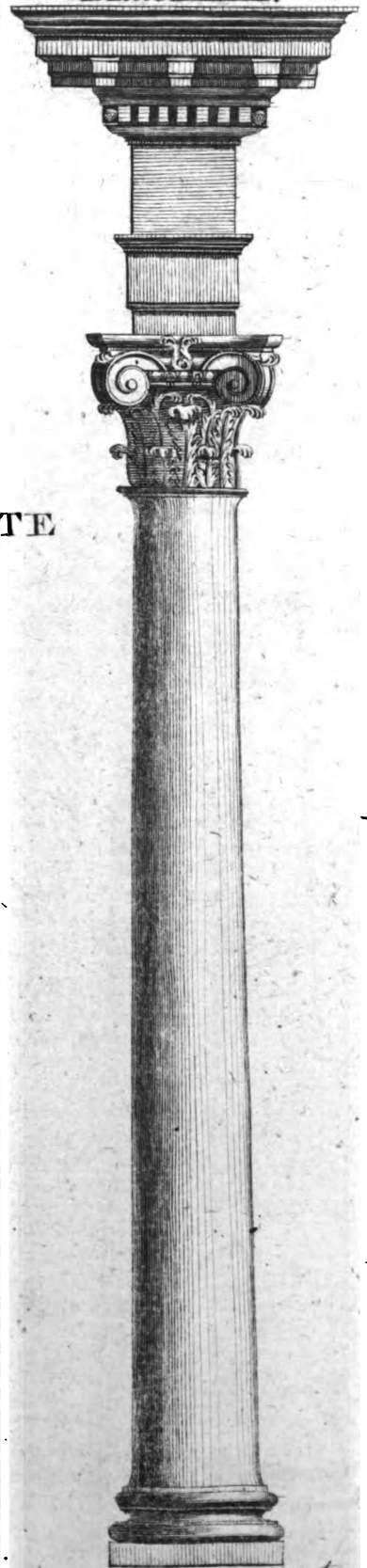
The  
CORINTHIAN  
ORDER





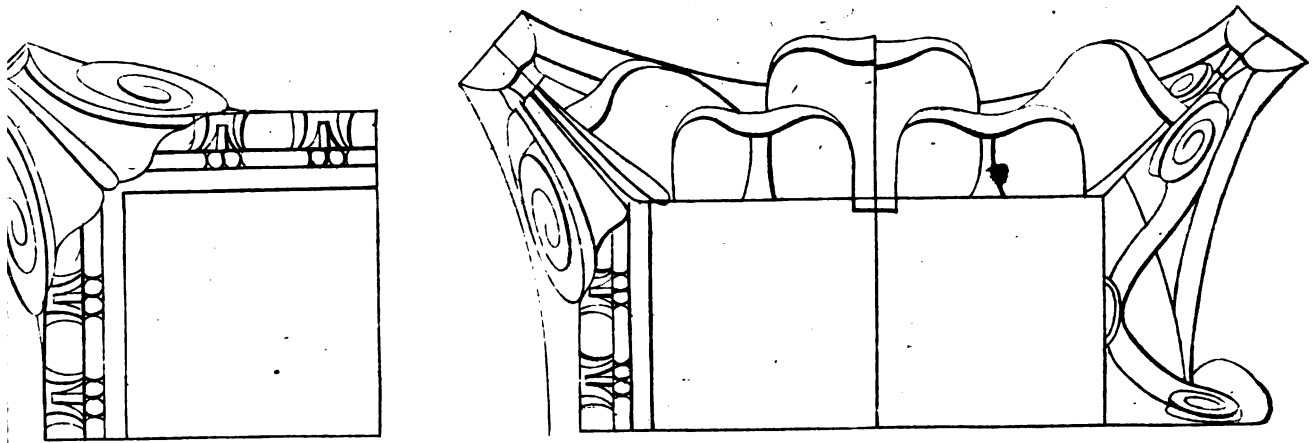


The  
COMPOSITE  
ORDER

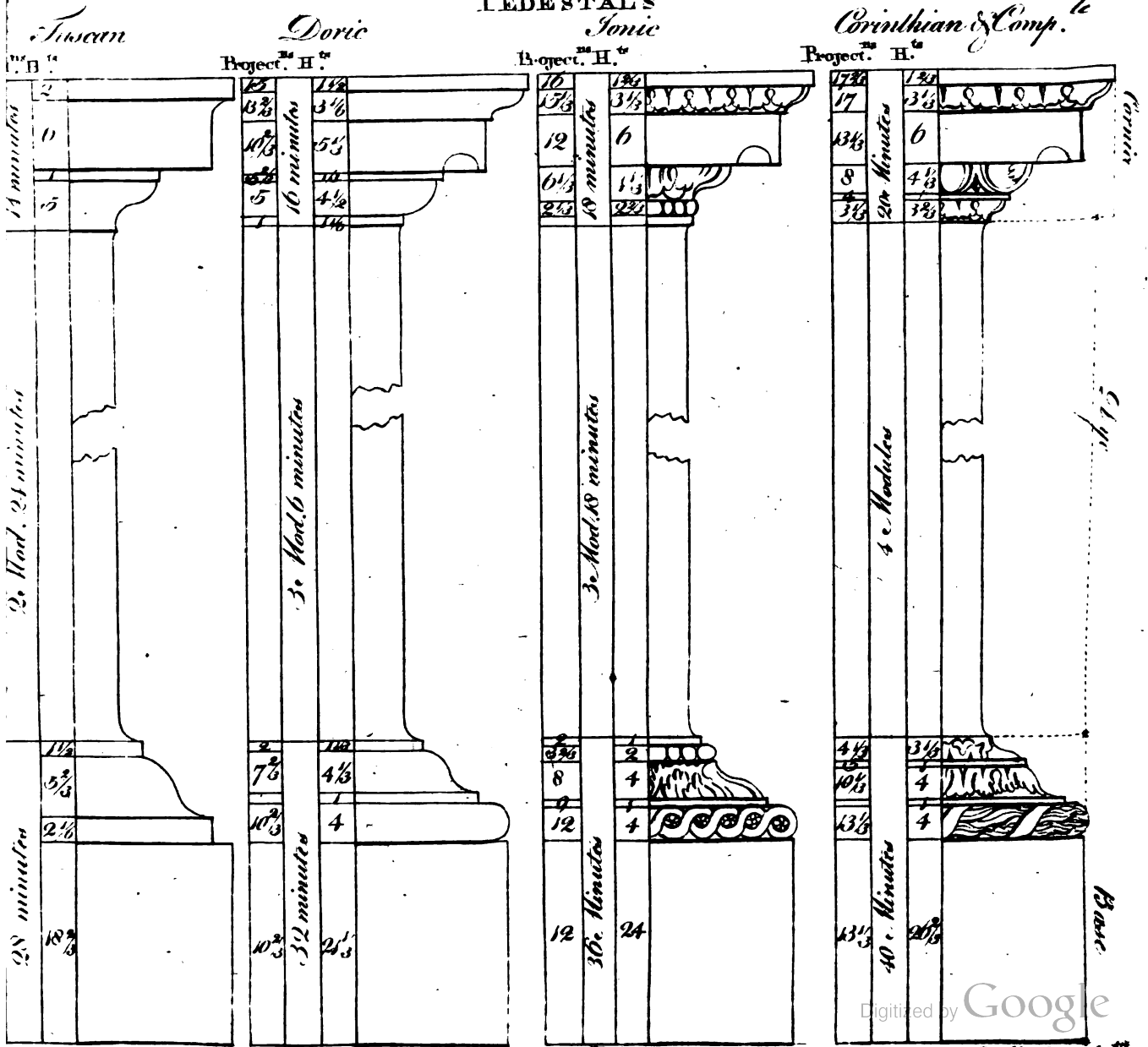


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PEDESTALS



OF PILASTERS.

PILASTERS differ from columns only in their plan; which is square, as that of columns is round. Their bases, capitals, and entablatures, have the same parts, with the same heights and projections, as those of columns: They are also distinguished in the same manner, by the names of Tuscan, Doric, Ionic, Corinthian, and Composite.

The column is undoubtedly more perfect than the pilaster. However, they may be employed with great propriety on many occasions. Some authors declaim against pilasters, because, according to them, they do not admit of diminution. But this is a mistake; there are many instances, in the remains of antiquity, of their being diminished. Scamozzi always gave his pilasters the same diminution as his columns: Palladio and Inigo Jones have likewise diminished them in many of their buildings.

Pilasters are employed in churches, galleries, halls, and other interior decorations, to save room; for, as they seldom project beyond the solid wall above one quarter of their diameter, they do not occupy near so much space as columns. They are likewise used in exterior decorations; sometimes alone, instead of columns, on account of their being less expensive; and sometimes they accompany columns, being placed behind them to support the architraves, where they enter the building, as in the Pantheon at Rome; or, in the same line with them, to fortify the angles, as in the portico of Septimius.

When pilasters are used alone, they should project one quarter of their diameter beyond the walls. When placed behind columns, especially if they be very near them, they need not project above one eighth of their diameter. But, when placed on a line with columns, their projection must be regulated by that of the columns; and consequently, it can never be less than a semidiameter, even when the columns are engaged as much as possible.

The shafts of pilasters are frequently adorned with flutings, in the same manner as those of columns; the plan of which may be a trifle more than a semicircle: Their number must be seven on each face, which makes them nearly of the same size with those of columns. The intervals, or fillets, must either be one third or one fourth of the fluting in breadth.

The capitals of pilasters are profiled nearly in the same manner as those of columns.

OF PERSIANS AND CARYATIDES.

BESIDES columns and pilasters, it is sometimes customary to employ representations of the human figure, to support entablatures in buildings. The male figures are called *Persians*; and the female, *Carians*, or *Caryatides*. The ancients made frequent use of Persians and Caryatides, and delighted in diversifying them a thousand ways. The modern artists have followed their example; and there is a great variety of compositions of this kind to be met with in different parts of Europe.

Indecent attitudes, distorted features, and all monstrous productions, ought to be avoided, of which there are many examples in Gothic buildings. On the contrary, the attitudes should be simple and graceful, the countenance always pleasing, though varied and strongly marked agreeable to the nature of the object represented.

The Caryatides, or female figures, should never much exceed the human size. But the Persians, or male figures, may be of any size; and the larger the better, as they will strike the beholder with the greater awe and astonishment. Persians may be used with propriety in arsenals, galleries of armour, &c. under the figures of captives, heroic virtues, &c. Their entablature ought to be Doric, and bear the same proportion to them as to columns of the same height. The entablature for Caryatides ought to be either Ionic or Corinthian, according as the character of the figures is more or less delicate.

Termini are sometimes employed, instead of Persians or Caryatides, to support the entablatures of monuments, chimney-pieces, and such like compositions. These figures owe their origin to the stones used by the ancients to mark the limits of particular possessions. Numa Pompilius, to render these inviolable, consecrated the terminus into a deity, and instituted festivals and sacrifices to his honour. In a short time, what was formerly only large upright stones, were represented in human shape; and afterwards introduced as ornaments to temples and other buildings. The termini are now principally used as ornaments for gardens and fields.

OF PEDESTALS.

MOST writers consider the PEDESTAL as a necessary part of the order, without which it is not complete. It is indeed a matter of little importance whether it be considered in that light, or as a distinct composition: We shall therefore treat of a pedestal as a distinct body, having no more connection with the order than an Attic, a basement, or any other part with which it may on some occasions be associated.

A pedestal consists of three principal parts; the base, the dye, and the cornice. The dye is always nearly of the same figure; being constantly either a cube or a parallelepipedon: But the base and cornice are varied and adorned with more or fewer mouldings, according to the simplicity or richness of the composition in which the pedestal is employed. Hence pedestals are, like columns, distinguished by the names of Tuscan, Doric, Ionic, Corinthian, and Composite.

Some authors are averse to pedestals, and compare a column raised on a pedestal to a man mounted on stilts; imagining that they were introduced merely from necessity, and for want of columns of a sufficient length. It is indeed true, that the ancients often made use of artifices to lengthen their columns; as appears by some that are in the Baptistery of Constantine at Rome; the shafts of which being too short for the building, were lengthened and joined to their bases by an undulated sweep, adorned with acanthus leaves. Nevertheless, there are many occasions where pedestals are evidently necessary; and some in which the order, were it not so raised, would

lose much of its beautiful appearance. Thus, in the insides of churches, if the columns that support the vault were placed immediately on the ground, the seats would hide their bases, and a good part of their shafts; and in the theatres of the ancients, if the columns of the scene had been placed immediately on the stage, the actors would have hid a part of them from the audience. In interior decorations, a pedestal diminishes the parts of the order, which otherwise might perhaps appear too clumsy, and hath the advantage of placing the column in a more favourable view, by raising its base nearer the level of the spectator's eye. In a second order of arcades, there is no avoiding pedestals; as without them it is impossible to give the arches any tolerable proportion.

With regard to the proportion that pedestals ought to bear to that of the column they support, it is by no means fixed. Both the ancients and moderns vary greatly on this head. Vignola's proportions are generally reckoned the best. He makes his pedestals, in all the orders, of the same height, viz. one third of the column; and as their breadth of course increases or diminishes in the same degree as the diameters of their respective columns do, the character of the order is always preserved, which, according to any other method, is impossible.

As to the divisions of the pedestal; if the whole height be divided into nine parts, one of them may be given to the height of the cornice, two to the base, and the six remaining to the shaft. The breadth of the shaft is always made equal to that of the plinth of the column. The projection of the cornice may be made equal to its height; and the base being divided into three parts, two of them will be for the height of the plinth; and one for the mouldings, whose projection must be less than that of the cornice. These measures are common to all pedestals. See Plate XXX.

## OF INTERCOLUMNIATIONS.

COLUMNS are either engaged, or insulated; and, when insulated, are either very near the wall, or at a considerable distance from it. Engaged columns, or such as are near the walls of a building, are not limited in their intercolumniations, as these depend on the breadths of the arches, windows, niches, or other decorations placed between the columns. But columns that are entirely detached, and perform alone the office of supporting the entablature, as in peristyles, porches, and galleries, must be near each other, for the sake both of real and apparent solidity.

The intercolumniations among the ancients were various. Those used in the Ionic and Corinthian orders were the pycnostyle, of which the interval was equal to one diameter and a half of the column; the systyle, whose interval was equal to two diameters; the eustyle, to two and a quarter; the diastyle to three, and the aræostyle to four. In the Doric order, they used other intercolumniations, regulating them by the triglyphs, one of which was always placed directly over the middle of each column; so that they were either systyle, mono-triglyph, of one diameter and a half; diastyle, of two

diameters and three quarters; or aræostyle, of four diameters; and the Tuscan intervals were very wide, some of them being above seven diameters, which was very practicable, as the architraves were of wood.

Among these different intercolumniations, the pycnostyle and systyle are too narrow; for although the ancients made frequent use of them, that ought rather to be ascribed to necessity than choice. For, as the architraves were composed of single stones, extending from the middle of one column to the middle of another, it would have been difficult, especially in large buildings, to find blocks of a sufficient length for diastyle intervals. With regard to the aræostyle and Tuscan intercolumniations, they are by much too wide, and can only be used in rustic buildings, where the architraves are of wood; neither is the diastyle sufficiently solid in large compositions. The eustyle is a medium between the narrow and broad intervals; and, being at the same time both spacious and solid, hath been preferred to any of the rest by the ancients as well as the moderns.

Vignola observed nearly the same proportion in all his intercolumniations; which practice, though condemned by several writers, is certainly preferable to any other, as it preserves the character of each order, and maintains in all of them an equal degree of real solidity. Setting aside therefore the pycnostyle and systyle dispositions on account of their want of space, and the aræostyle for its deficiency in point of strength, it may be established, that the diastyle and eustyle intercolumniations, (the latter of which, on most occasions, ought to have the preference); may be employed in all the orders without distinction, excepting the Doric; in which the most perfect interval is ditriglyph; neither the monotriglyph, nor the aræostyle, being to be suffered but in cases of necessity.

Sometimes, on account of the windows, doors, niches, and other decorations, which correspond with the intercolumniations of the peristyle, or gallery, it is not possible to make the intervals so narrow as eustyle, or even as diastyle: Wherefore the moderns, authorised by some few examples of the ancients, where grouped columns are employed, have invented a manner of disposing them, called by Perrault *aræostyle*, which admits of a larger interval, without any detriment to the apparent solidity of the building. This kind of disposition is composed of two systyle intercolumniations; the column that separates them being approached towards one of those at the extremities, sufficient room only being left between them for the projection of the capitals; so that the great space is three diameters and a half wide, and the little one half a diameter.

In peristyles, galleries, or porticos, all the intercolumniations must be equal: But in a logio, or porch, the middle interval may be broader than the others, by a triglyph or modillion, or three or four dentils; unless the columns at the angles be coupled, or grouped with pilasters; in which case, all the intervals should be of the same dimensions.

When buildings are very small, as is frequently the case in temples and other inventions used for ornamenting gardens, the intercolumniations may be broader, in proportion to the diameter of the columns, than usual; be-

cause, when they are nearer each other than three feet, there is hardly room for a bulky person to pass between them.

OF ARCHES.

ARCHES are not so magnificent as colonnades; but they are more solid, and less expensive. They are proper for triumphal entrances, gates of cities, of palaces, of gardens, and of parks; and, in general, for all openings that require an extraordinary breadth.

There are various manners of adorning arches. Sometimes their piers are rusticated; sometimes they are adorned with palasters, terminæ, or caryatides; and sometimes they are made sufficiently broad to admit niches, or windows. The circular part of the arch is either surrounded with rustic key-stones, or with an archivolt enriched with mouldings; which, in the middle, is sometimes interrupted by a console, a mask, serving at the same time as a key to the arch, and as a support to the architrave of the order. The archivolt is sometimes supported by an impost, at the head of the pier; and, at others, by columns placed on each side of it, with a regular entablature, or architrave cornice. There are likewise instances of arcades without piers, the arches being turned on single columns, as in the temple of Faunus at Rome; &c. This practice, however, ought to be seldom imitated, as it is neither solid nor handsome.

When arches are large, the key-stone should never be omitted, but cut in the form of a console, and carried close under the soffit of the architrave, which, on account of its extraordinary length, requires a support in the middle. The imposts of arches should never be omitted; at least, if they be, a platform ought to supply their place. If columns are employed without pedestals in arcades, they should always be raised on a plinth. In all arches, the circular part ought not to spring immediately from the impost, but take its rise at such a distance above it, as is necessary in order to have the whole curve seen at the proper point of view.

The void or aperture of arches should never be higher, nor much lower, than double their breadth; the breadth of the pier should seldom exceed two thirds, nor be less than one third, of the breadth of the arch; and the angular pier ought to be broader than the others, by one half, one third, or one fourth; the impost should not be more than one seventh, nor less than one ninth of the aperture; and the archivolt must not be more than one eighth, nor less than one tenth of it. The breadth of the console must, at the bottom, be equal to that of the archivolt; and its sides must be drawn from the centre of the arch: The length of it must not be less than one and a half of its smallest breadth, nor more than double. The thickness of the pier depends on the breadth of the portico; for it must be strong enough to resist the pressure of its vault. But, with regard to the beauty of the building, it should not be less than one quarter of the breadth of the arch, nor more than one third. These are the general dimensions of arches.

OF ORDERS ABOVE ORDERS.

When, in a building, two or more orders are employ-

ed, one above another, the laws of solidity require, the strongest should be placed lowermost. Hence the Tuscan must support the Doric, the Doric the Ionic, the Ionic the Composite or Corinthian, and the Composite the Corinthian.

This rule, however, is not always strictly adhered to. Most authors place the Composite above the Corinthian. There are likewise examples where the same order is repeated, as in the theatre of Statilius Taurus, and the Coliseum; and others, where an intermediate order is omitted, and the Ionic placed on the Tuscan, or the Corinthian on the Doric. But none of these practices ought to be imitated.

In placing columns above one another, the axis of all the columns ought to correspond, or be in the same perpendicular line, at least in front.

With regard to the proportions of columns placed above each other, Scamozzi's rule, That the lower diameter of the superior column should constantly be equal to the upper diameter of the inferior one, is universally esteemed the best; and gives all the columns the appearance of one long tapering tree, cut into several pieces. According to this rule, the Doric column will be to the Tuscan, as 13½ to 14; the Ionic to the Doric, as 15 to 16; the Composite or Corinthian to the Ionic, as 16½ to 18; and the Corinthian to the Composite, as 16½ to 20.

In Britain there are few examples of more than two stories of columns in the same aspect: And, though in Italy, and other parts of Europe, we frequently meet with three, and sometimes more; yet it is a practice by no means to be imitated; for there is no possibility of avoiding many striking inconsistencies, or of preserving the character of each order in its intercolumnial decorations.

OF BASEMENTS AND ATTICS.

INSTEAD of employing several orders one above the other in a composition, the ground-floor is sometimes made in the form of a *basement*; on which the order that decorates the principal story is placed. The proportion of these basements is not fixed, but depends on the nature of the rooms on the ground-floor. In the palace of the Porti in Vicenza, the height of the basement is equal to that of the order. In some buildings, its height exceeds two thirds of that of the order; and in others only half the height of the order. It is not, however, advisable to make the basement higher than the order it supports; neither should it be lower than one half of the order.

The usual method of decorating basements is with rustics of different kinds. The best, where neatness and finishing is aimed at, are such as have a smooth surface. Their height, including the joint, should never be less; nor much more, than half a module of the order placed on the basement. Their figure may be from a square to a sesquialtera; and their joints may be either square or chamfered. The square ones should not be broader than one eighth of the height of the rustic, nor narrower than one tenth; and their depth must be equal to their breadth; those that are chamfered, must form a rectangle; and the breadth

breadth of the whole joint may be from one fourth to one third of the height of the flat surface of the rustica.

Instead of a second order, it is sometimes usual to crown the first with an **ATTIC STORY**: These Attics should never exceed in height one third of the height of the order on which they are placed, nor be less than one quarter of it. Their figure is that of a pedestal: The base, dye, and cornice, of which they are composed, may bear the same proportions to each other as those of pedestals do; and the base and cornice may be composed of the same mouldings as those of pedestals. Sometimes the Attic is continued throughout; at others, it projects, and forms a pilaster over each column of the order. The breadth of this pilaster is seldom made narrower than the upper diameter of the column below it, and never broader. Its projection may be equal to one quarter of its breadth.

### OF PEDIMENTS.

**PEDIMENTS** most probably owe their origin to the inclined roofs of the primitive huts. Among the Romans, they were used only as coverings to their sacred buildings, till Cæsar obtained leave to cover his house with a pointed roof, after the manner of temples. In the remains of antiquity we meet with two kinds of pediments, the triangular and circular. The former of these are promiscuously applied to cover small or large bodies: But the latter being of a heavier figure, are never used but as coverings to doors, niches, windows, or gates.

As a pediment represents the roof, it should never be employed but as a finishing to the whole composition.

The ancients introduced but few pediments into their buildings, usually contenting themselves with a single one to adorn the middle or principal part. But some of the moderns, and particularly the Italians, have been so immoderately fond of them, that their buildings frequently consist of almost nothing else.

The girder being a necessary part in the construction of a roof, it is an impropriety to intermit the horizontal entablature of a pediment, by which it is represented, to make room for a niche, an arch, or a window.

In regular architecture, no other form of pediments can be admitted, besides the triangular and circular. Both of them are beautiful: and when a considerable number of pediments are introduced, as when a range of windows are adorned with them, these two figures may be used alternately, as in the niches of the Pantheon, and in those of the temple of Diana at Nismes.

The proportion of pediments depends upon their size; for the same proportions will not do in all cases. When the base of the pediment is short, its height must be increased; and when the pediment is long, the height must be diminished. The best proportion for the height is from one fifth to one fourth of the base, according to the extent of the pediment, and the character of the body it covers. The materials of the roof must also be attended to; for if it be covered with tyles, it will be necessary to raise it more than one quarter of the base, as was the custom of the ancients in their Tuscan temples.

The tympan is always on a line with the front of the frieze; and, when large, admits of various ornaments.

### OF BALLUSTRADES.

**BALLUSTRADES** are sometimes of real use in buildings; and at other times they are only ornamental. Such as are intended for use, as when they are employed in stair-cases, before windows, or to inclose terrasses, &c. must always be nearly of the same height; never exceeding three-feet and a half, nor ever less than three. But those that are principally designed for ornament, as when they finish a building, should be proportioned to the architecture they accompany; and their height ought never to exceed four fifths of the height of the entablature on which they are placed; nor should it ever be less than two thirds thereof, without counting the zocholo, or plinth, the height of which must be sufficient to leave the whole ballustrade exposed to view.

The best proportion for ballustrades is to divide the whole given height into thirteen equal parts; eight of these for the height of the balluster, three for the base, and two for the cornice or rail; or into fourteen, (if it be required to make the balluster less), giving eight parts to the balluster, four to the base, and two to the rail. One of these parts may be called a module; and, being divided into nine minutes, may serve to determine the dimensions of the particular members.

In ballustrades, the distance between two ballusters should not exceed half the diameter of the balluster measured in its thickest part, nor be less than one third of it.

The breadth of the pedestals, when they are placed on columns or pilasters, is regulated by them; the dye never being made broader than the top of the shaft, nor much narrower: and when there are neither columns nor pilasters in the front, the dye should not be much lower than a square, and seldom higher. On stairs, or any other inclined planes, the same proportions are to be observed as on horizontal ones.

### OF GATES, DOORS, AND PIERS.

There are two kinds of entrances, *viz.* doors and gates. The former serve only for the passage of persons on foot; but the latter likewise admit horsemen and carriages. Doors are used as entrances to churches, and other public buildings, to common dwelling-houses, and apartments: And gates serve for inlets to cities, fortresses, parks, gardens, palaces, &c. The apertures of gates being always wide, they are generally made in the form of an arch, that figure being the strongest. But doors, which are generally of small dimensions, are commonly parallelograms, and closed horizontally.

The general proportion for the apertures, both of gates and doors, whether arched or square, is, that the height be about double the breadth.

The usual ornaments of gates consist of columns, pilasters, entablatures, pediments, rustics of different kinds, imposta, archivolt, &c.; and the most common method of adorning doors is with an architrave, for rounding the





Fig. 1.

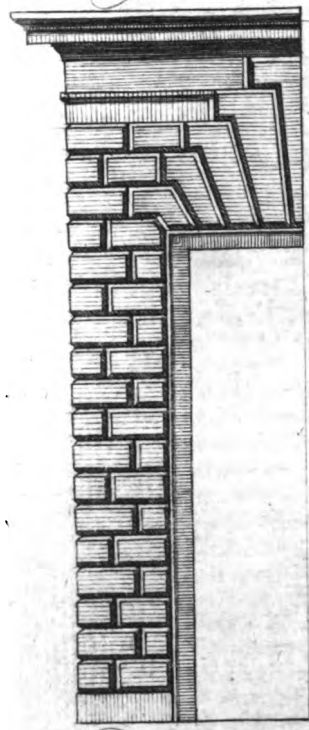


Fig. 2.

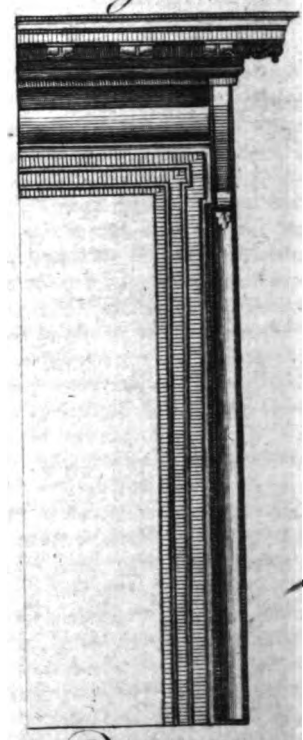
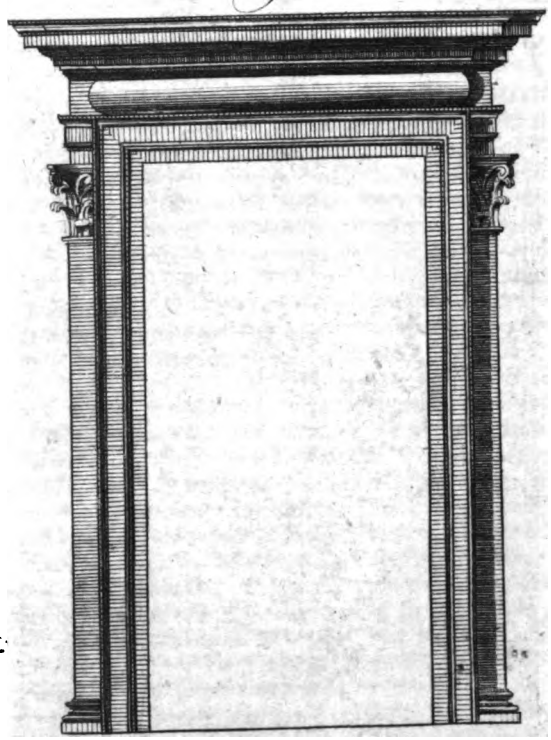


Fig. 4.

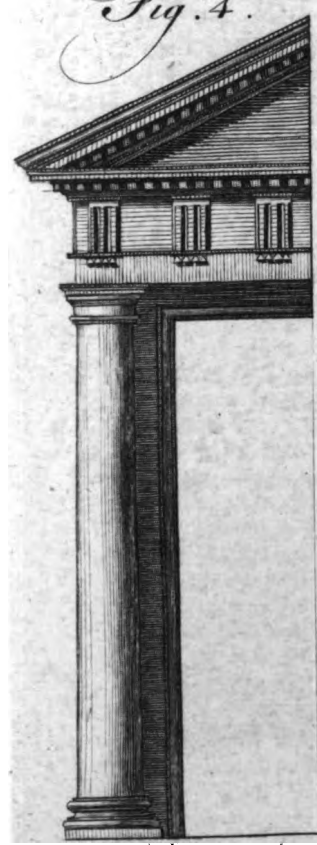


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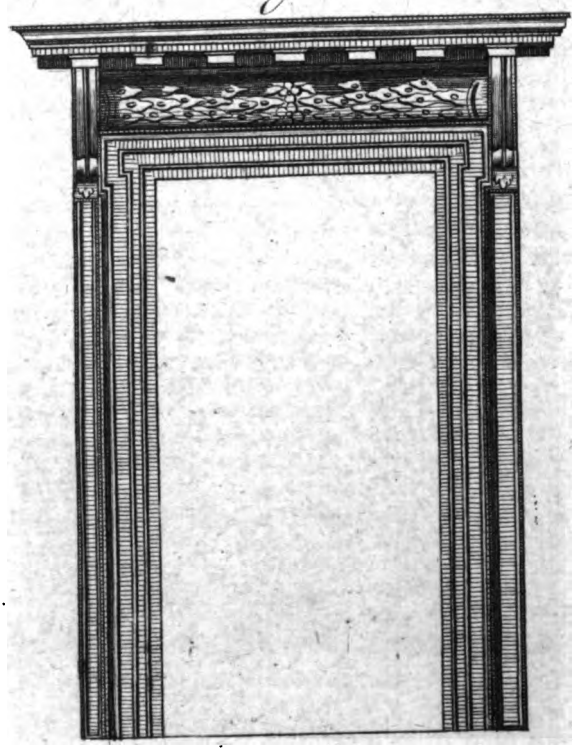
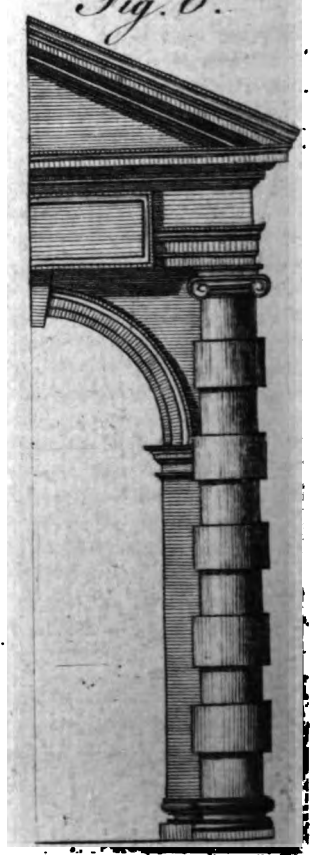


Fig. 6.



the sides and top of the aperture, on which are placed a regular frieze and cornice. Sometimes the cornice is supported by a couple of consoles placed on each side of the door; and sometimes, besides an architrave, the aperture is adorned with columns, pilasters, caryatides, or termini; and a regular entablature with a pediment.

Inside-doors, however small the building may be, should never be narrower than two feet nine inches; nor should they ever, in private houses, exceed three feet six inches in breadth, which is more than sufficient to admit the bulkiest person. Their height should at least be six feet three or four inches; otherwise a tall person cannot pass without stooping. In churches, palaces, &c. where there is a constant ingress and egress of people, the apertures must be larger. The smallest breadth that can be given to a gate is  $8\frac{1}{2}$  or 9 feet, which is but just sufficient for the passage of a coach.

Plate XXXI. Fig. 1. Is a rustic door, composed by the celebrated Vignola, in which the aperture occupies two thirds of the whole height, and one half of the whole breadth; the figure of it being a double square. The rustics may be either smooth or hatched; their joints must form a rectangle, and the breadth of each joint may be one third, or two sevenths, of the vertical surface of a rustic. The joints of the claveaux, or key-stones, must be drawn to the summit of an equilateral triangle, whose base is the top of the aperture. The architrave surrounding the aperture may be composed either of a large ogee and fillet, or of a plat-band and fillet. Its whole breadth must be one tenth of the breadth of the aperture; the remaining part of each pier being for the rustics. The entablature is Tuscan: The cornice is to be one sixteenth of the whole height of the door; and what remains below it being divided into twenty-one equal parts, the two uppermost of them will be for the frieze and architrave, and the remaining nineteen for the rustics and plinth at the foot of the door.

Fig. 2. Is a disposition of Michael Angelo's. The windows of the Capitol at Rome are of this kind; and Sir Christopher Wren hath executed doors of the same kind under the semicircular porches in the flanks of St Paul's. The figure of the aperture may be a double square; the architrave one sixth of the breadth of the aperture; and the whole entablature one quarter of its height. The front of the pilasters or columns, on each side, must be on a line with the fascia of the architrave; and their breadth must be a semidiameter.

Fig. 3. Is likewise a design of Vignola's. It is of the Corinthian order, and executed in the Cancellaria at Rome. The height is equal to double its breadth; and the whole ornament at the top is equal to one third of the height of the aperture. The architrave is in breadth one fifth of the breadth of the aperture; and the pilasters that support the consoles, are half as broad as the architrave. The whole is well imagined, but rather heavy; and it will be best to reduce the architrave to one sixth of the aperture, diminishing the entablature proportionally.

Fig. 4. Is a design of Serlio's. The aperture may be either twice as high as broad, or a trifle less. The diameter of the columns may be equal to one quarter of

the breadth of the aperture; and their height may be from eight diameters to eight and a half. The entablature must be somewhat less than one quarter of the height of the columns; and the height of the pediment may be one quarter of its base.

Fig. 5. Is a door in the salon of the Farnese at Rome, designed by Vignola. The aperture forms a double square. The entablature is equal to three elevenths of its height, the architrave being one of these elevenths; and the whole ornament on the sides, consisting of the architrave and pilasters, is equal to two sevenths of the breadth of the aperture: The cornice is Composite, enriched with mutules and dentils; and the frieze is adorned with a festoon of laurel.

Fig. 6. Is copied from a door at Florence, said to be a design of Cigoli's. The height of the aperture is a trifle more than twice its breadth. It is arched; and the impost is equal to half a diameter. The columns are Ionic, somewhat above nine diameters high; and their shafts are garnished each with five rustic cinctures. The entablature is less than one quarter of the column; and the breadth of the tablet, in which there is an inscription, is equal to the breadth of the aperture.

## O F W I N D O W S .

THE first consideration with regard to windows, is their size, which varies according to the climate, the destination of the building, &c. In Britain, the windows of the smallest private houses are commonly from 3 to  $3\frac{1}{2}$  feet broad; and being generally twice their breadth in height, or somewhat more, in the principal apartments, they generally rise to within a foot or two of the ceilings of the rooms, which are frequently no higher than 10 feet, and at most 12 or 13. But, in more considerable houses, the apartments are from 15 to 20 feet high, and sometimes more; and in these the windows are from 4 to 5 and  $5\frac{1}{2}$  feet broad, and high in proportion. These dimensions are sufficient for dwelling-houses of any size in this country; when they are larger, they admit too much of the cold air in winter. But churches, and other buildings of that kind, may have larger windows, proportioned to the size of the structures.

The proportions of the apertures of windows depend upon their situation. Their breadth in all the stories must be the same; but the different heights of the apartments make it necessary to vary the height of the windows likewise. In the principal floor, it may be from  $2\frac{1}{2}$  of the breadth to  $2\frac{2}{3}$ , according as the rooms have more or less elevation. In the ground-story, where the apartments are lower, the apertures of the windows seldom exceed a double square; and, when they are in a rustic basement, they are frequently made much lower. The height of the windows of the second floor may be from  $1\frac{1}{2}$  of their breadth to  $1\frac{2}{3}$ ; and Attics and Mezzanines may be either a perfect square, or somewhat lower.

The windows of the principal floor are generally most enriched. The simplest method of adorning them is, with an architrave surrounding the aperture, and crowned with a frieze and cornice. The windows of the ground-floor are sometimes left entirely plain, without

any ornament; and at others they are surrounded with rustics, or a regular architrave with a frieze and cornice. Those of the second floor have generally an architrave carried entirely round the aperture; and the same is the method of adorning Attic and Mezzanine windows: But the two last have seldom either frieze or cornice; whereas the second-floor windows are often crowned with both.

The breasts of all the windows on the same floor should be on the same level, and raised above the floor from two feet nine inches to three feet six inches at the very most. When the walls are thick, the breasts should be reduced under the apertures, for the conveniency of looking out. In France, the windows are frequently carried quite down to the floor. When the building is surrounded with gardens, or other beautiful objects, this method renders the rooms exceeding pleasant.

The interval between the apertures of windows depends in a great measure on their enrichments. The breadth of the aperture is the least distance that can be between them; and twice that breadth should be the largest in dwelling-houses; otherwise the rooms will not be sufficiently lighted. The windows in all the stories of the same aspect must be placed exactly above one another.

Plate XXXII. Fig. 1. Is a design of P. Lescot, abbot of Clagny, executed in the old Louvre at Paris. The apertures may be a double square, or a trifle more; the architrave from one sixth to one seventh of the breadth of the aperture: The pilaster is equal to that breadth, when the architrave is narrow; or less, by one quarter, or one fifth, when it is broad. The whole entablature should not exceed one quarter of the height of the aperture, nor be much lower. The consoles may be equal in length to half the breadth of the aperture at most, and to one third of it at least.

Fig. 2. Is a design of Palladio's, executed at the Chiericato in Vincenza: Its proportions are not much different from the following. The plat-band that supports the window is equal to the breadth of the architrave.

Fig. 3. Is likewise a design of Palladio's, executed by him in many of his buildings. The aperture is a double square. The breadth of the architrave is one sixth of the breadth of the aperture; and the frieze and cornice together are double the height of the architrave. The breadth of the consoles is two thirds of the breadth of the architrave.

Fig. 4. Is a design of Ludovico Da Cigoli; and executed in the ground-floor of the Raanuhini palace at Florence.

Fig. 5. Is a design of Inigo Jones, executed at the Banqueting-house. The aperture may be a double square; the architrave may be one sixth of its breadth; the whole entablature one quarter of its height; and the breadth of the consoles two thirds of the breadth of the architrave.

Fig. 6. Is a design of M. Angelo Buonaroti, executed at the Farnese.

## OF NICHEs AND STATUES.

It hath been customary, in all ages, to enrich differ-

ent parts of buildings with representations of the human body. Thus the ancients adorned their temples, baths, theatres, &c. with statues of their deities, heroes, and legislators. The moderns still preserve the same custom, placing in their churches, palaces, &c. statues of illustrious persons, and even groups composed of various figures, representing occurrences collected from history, fables, &c. Sometimes these statues or groups are detached, raised on pedestals, and placed contiguous to the walls of a building, or in the middle of a room, court, or public square. But they are most frequently placed in cavities made in the walls, called *niches*. Of these there are two sorts; the one formed like an arch in its elevation, and semicircular or semielliptical in its plan; the other is a parallelogram both in its plan and elevation.

The proportion of both these niches depends on the character of the statues, or the general form of the groups placed in them. The lowest are at least a double square in height; and the highest never exceed  $2\frac{1}{2}$  of their breadth.

With regard to the manner of decorating them, when they are alone in a composition, they are generally inclosed in a pannel, formed and proportioned like the aperture of a window, and adorned in the same manner. In this case, the niche is carried quite down to the bottom; but on the sides and at the top, a small space is left between the niche and the architrave of the pannel. And when niches are intermixed with windows, they may be adorned in the same manner with the windows, provided the ornaments be of the same figure and dimensions with those of the windows.

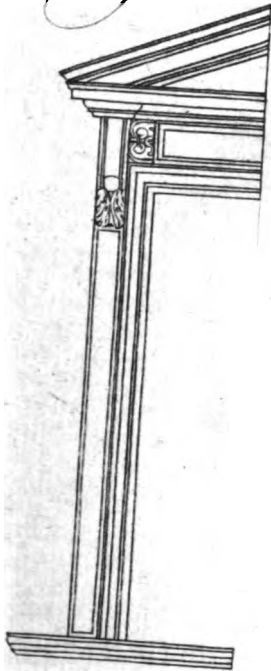
\*The size of the statues depends on the dimensions of the niches. They should neither be so large as to have the appearance of being rammed into the niches, as in Santa Maria Maggiore at Rome; nor so narrow as to seem lost in them, as in the Pantheon. The distance between the outline of the statue and side of the niche should never be less than one third of a head, nor more than one half, whether the niche be square or arched; and when it is square, the distance from the top of the head to the ceiling of the niche should not be greater than the distance on the sides. Statues are generally raised on a plinth, the height of which may be from one third to one half of a head; and sometimes, where the niches are large, the statues may be raised on small pedestals.

The character of the statue should always correspond with the character of the architecture with which it is surrounded. Thus, if the order be Doric, Hercules, Jupiter, Mars, Æsculapius, and all male statues representing beings of a robust and grave nature, may be introduced; if Ionic, then Apollo, Bacchus, &c.; and if Corinthian, Venus, Flora, and others of a delicate nature, should be employed.

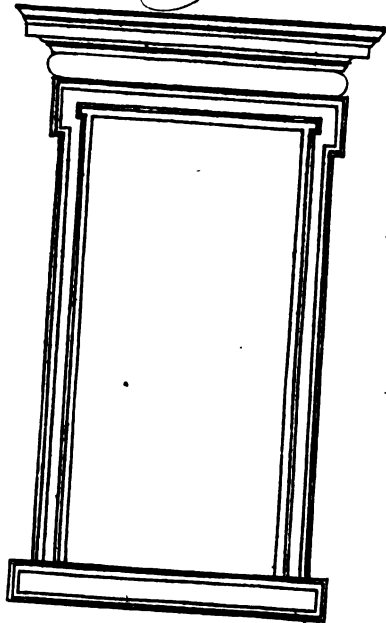
## OF CHIMNEY-PIECES.

AMONG the ancients, there are very few examples of chimney-pieces to be met with. Neither the Italians nor French have excelled in compositions of this kind. Britain, by being possessed of many able sculptors at different

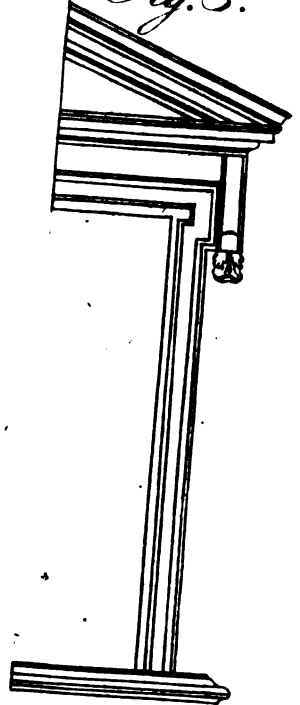
*Fig. 1.*



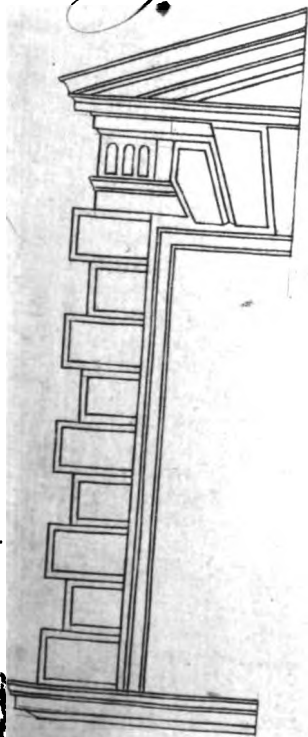
*Fig. 2.*



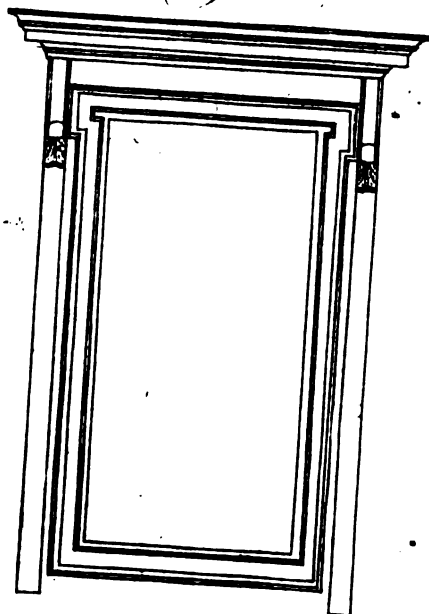
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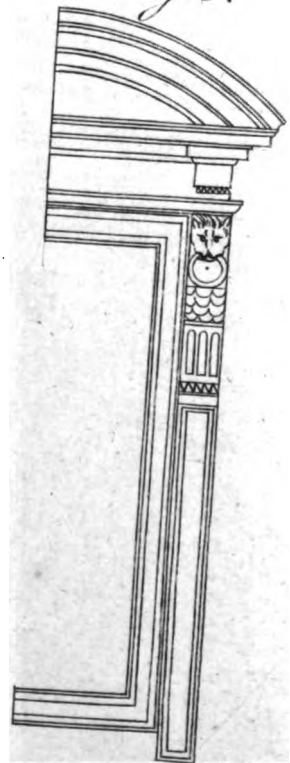
*Fig. 4.*



*Fig. 5.*



*Fig. 6.*

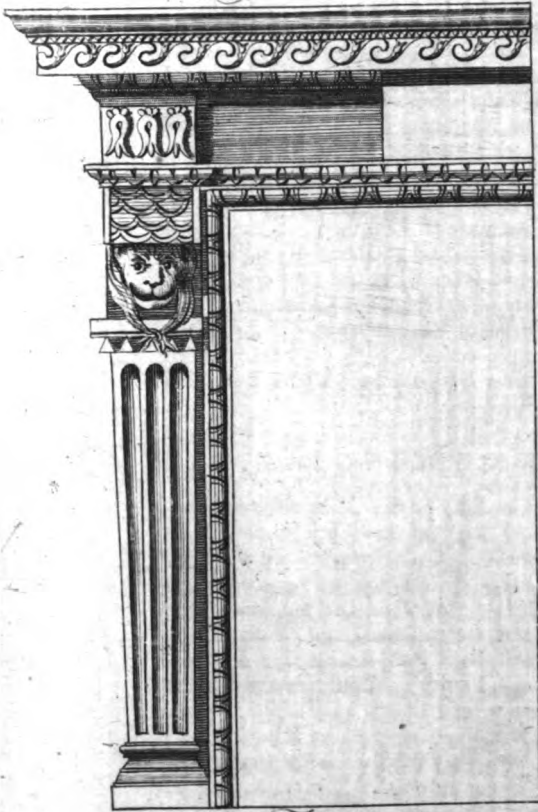




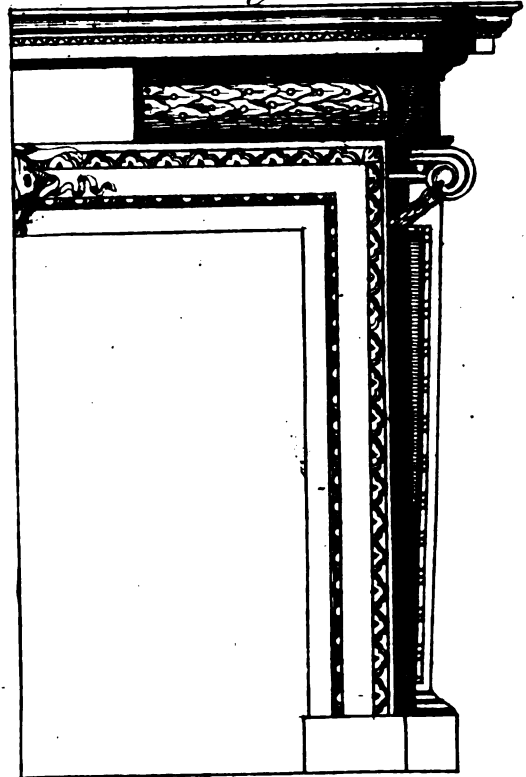
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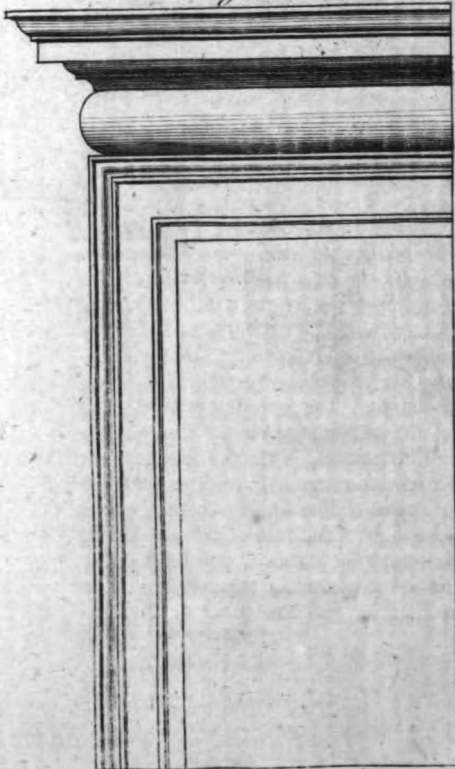
*Fig. 1.*



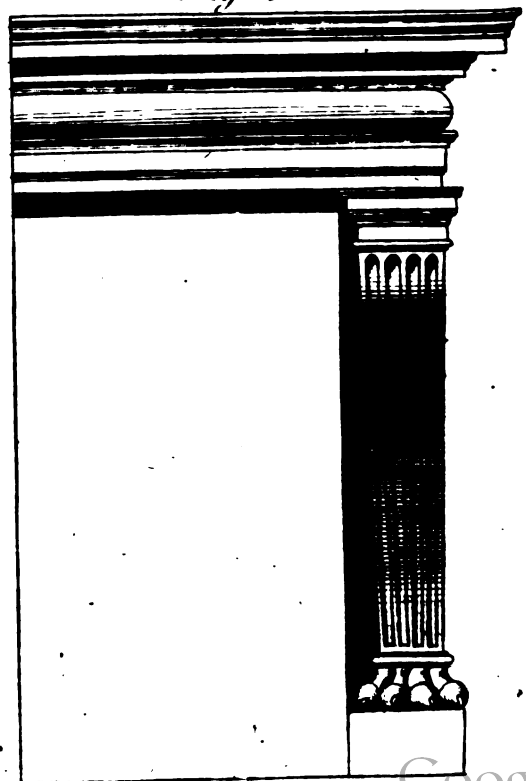
*Fig. 2.*



*Fig. 3.*



*Fig. 4.*





different times, has surpassed all other nations, both in taste of design, and workmanship.

The size of the chimney must be regulated by the dimensions of the room where it is placed. In the smallest apartments, the breadth of the aperture should never be less than three feet, to three feet six inches. In rooms from 20 to 24 feet square, or of equal superficial dimensions, it may be from 4 to  $4\frac{1}{2}$  feet broad; in those of 24 to 27, from  $4\frac{1}{2}$  to 5; and, in such as exceed these dimensions, the aperture may even be extended to  $5\frac{1}{2}$  or 6 feet.

The chimney should always be situate so as to be immediately seen by those who enter the room. The middle of the partition wall is the most proper place in halls, salons, and other rooms of passage; but in drawing-rooms, dressing-rooms, and the like, the middle of the back wall is the best situation. In bed-rooms, the chimney is always in the middle of one of the partition-walls; and in closets, and other very small places, to save room, it is put in a corner. Where-ever two chimneys are used in the same room, they should be placed either directly facing each other, if in different walls, or at equal distances from the centre of the wall in which they both are.

The proportion of the apertures of chimney-pieces of a moderate size is generally a perfect square; in small ones, it is a trifle higher; and in large ones, a trifle lower. Their ornaments consist in architraves, frizes, cornices, columns, pilasters, termini, caryatides, consoles, and all kinds of ornaments of sculpture, representing animals and vegetables, &c. likewise vases, chalcices, trophies of arms, &c. In designing them, regard must be had to the nature of the place where they are to be employed. Such as are intended for halls, salons, guard-rooms, galleries, and other large places, must be composed of large parts, few in number, of distinct and simple forms, and having a bold relief; but chimney-pieces for drawing-rooms, dressing-rooms, &c. may be of a more delicate and complicated nature.

Chimney-pieces are composed of wood, stone, or marble; the last of which ought to be preferred, as figures or profiles are best represented in a pure white.

Plate XXXIII. Fig. 1, 2, 3, and 4. are different designs for chimney-pieces by Palladio and Inigo Jones. Their proportion may be gathered from the designs, which are accurately executed.

OF THE PROPORTIONS OF ROOMS.

THE proportions of rooms depend in a great measure on their use, and actual dimensions: But, with regard to beauty, all figures, from a square to a sesquialteral, may be employed for the plan.

The height of rooms depends on their figure. Flat ceiled ones may be lower than those that are coved. If their plan be a square, their height should not exceed five sixths of the side, nor be less than four fifths; and when it is oblong, their height may be equal to their breadth. But coved rooms, if square, must be as high as broad; and when oblong, they may have their height equal to their breadth, more one fifth, one quarter, or

even one third of the difference between the length and breadth: And galleries should at least be in height one and one third of their breadth, and at most one and a half, or one and three fifths.

The coldness the British climate is a strong objection to high rooms; so that it is not uncommon to see the most magnificent apartments not above 15, 16, or at most 18 feet high; though the extent of the rooms would require a much more considerable elevation. But, where beauty is aimed at, this practice ought not to be imitated.

When rooms are adorned with an intire order, the entablature should never exceed one sixth of the whole height in flat-ceiled rooms, and one sixth of the upright part in coved ones; and when there are neither columns nor pilasters, but only an entablature, its height should not be above one seventh of these heights. If the rooms be finished with a simple cornice, it should never exceed one fourteenth, nor ever less than one fifteenth part of the above-mentioned height.

OF CEILINGS.

CEILINGS are either flat, or coved, in different manners. The simplest of the flat kind are those adorned with large compartments, surrounded with one or several mouldings, either let into the ceiling, or projecting beyond its surface: And when the mouldings that form the compartments are enriched, and some of the compartments adorned with well-executed ornaments, such ceilings have a good effect, and are very proper for common dwelling-houses, and all low apartments. Their ornaments and mouldings do not require a bold relief; but, being near the eye, they must be finished with taste and neatness. For higher rooms, a flat ceiling which has the appearance of being composed of various joists framed into each other, and forming compartments of various geometrical figures, should be employed. The sides of the joists forming the compartments are generally adorned with mouldings, and represent either a simple architrave, or an architrave-cornice, according to the size of the compartments and the height of the room.

Coved ceilings are more expensive; but they are likewise more beautiful. They are used promiscuously in large and small rooms, and occupy from one fifth to one third of the height of the room. If the room be low in proportion to its breadth, the cove must be likewise low; and when it is high, the cove must be so likewise: By which means the excess of the height will be rendered less perceptible. But, where the architect is at liberty to proportion the height of the room to its superficial dimensions, the most eligible proportion for the cove is one fourth of the whole height. In parallelogram-figured rooms, the middle of the ceiling is generally formed into a large flat panel. This panel, with the border that surrounds it, may occupy from one half to three fifths of the breadth of the room. The figure of the cove is commonly either a quadrant of a circle or of an ellipse, taking its rise a little above the cornice, and finishing at the border round the great panel in the centre. The border projects somewhat beyond the coves on the outside.

side; and, on the side towards the pannel, it is generally made of a sufficient depth to admit the ornaments of an architrave, or architrave and cornice.

In Britain, circular rooms are not much in use; but they are very beautiful. Their height must be the same with that of square rooms; their ceilings may be flat; but they are handfomer when coved, or of a concave form.

*Arcs doubleaux*, or soffits of arches, when narrow, are ornamented with *gullochis*, or frets; but, when broad, they may be adorned in a different manner.

When the profiles of the room are gilt, the ceilings ought likewise to be gilt. The usual method is to gild all the ornaments, and to leave the grounds white, pearl colour, light blue, or of any other tint proper to set off the gilding to advantage. Painted ceilings, so common in France and Italy, are but little used in Britain.

## OF STAIRS AND STAIR-CASES.

THERE are many kinds of stair-cases; for in some the steps are made straight; in others, winding; in others mixt of both. Of straight stairs, some fly directly forward; others are square; others triangular. Others are called French flights, or winding-stairs, (which in general are called spiral or cockle-stairs); of which some are square; some circular, or round; and some elliptical, or oval; and these again are various; for some wind about a solid, others about an open newel. Stairs mixt of straight and winding steps are also of various kinds; some are called dog-legged; some there are that wind about a solid newel; and others that fly about a square open newel.

Great care ought to be taken in placing of the stair-case in any building; and therefore stair-cases ought to be described, and accounted for justly, when the plan of a building is made. For want of this, sometimes unpardonable errors have been committed: Such as having a little blind stair-case to a large house; or, on the other hand, to have a large spacious stair-case to a little one.

Palladio says, in placing stair-cases, the utmost care ought to be taken, it being difficult to find a place convenient for them, that will not at the same time prejudice the rest of the building. But commonly the stairs are placed in the angle, wing, or middle of the front.

To every stair-case are required three openings.

First, the door leading thereto.

Secondly, the window, or windows, that give light to it;

And, thirdly, the landing.

First, the door leading to a stair-case should be so placed, that most of the building may be seen before you come at the stairs, and in such a manner that it may be easy for any person to find out.

Secondly, for the windows; if there be but one, it must be placed in the middle of the stair-case, that thereby the whole may be enlightened.

Thirdly, the landing of stairs should be large and spacious, for the convenient entering into rooms: In a word, stair-cases should be spacious, light, and easy in ascent.

The height of large steps must never be less than six inches, nor more than seven inches and a half.

The breadth of steps should never be less than 10 inches, nor more than 18 inches; and the length of them not less than three feet, nor more than 12.

Plate XXXIV. Fig. 1. A stair-case of two flights.—*A* shews the manner of drawing the *ramp*, which is to rise equal to the height of the first step of the next flight, and as much as its *kneeling*; as is shewn by the *ramp* intersecting the rail of the second flight.

Fig. 2. Shews the straight rail intersecting a circular cap.

Fig. 3. Section of two different hand-rails.

Fig. 4. Shews the manner of dove-tailing the riser into the step.

Plate XXXV. Fig. 1. Represents a stair-case, with flights, and its landing rail.

Fig. 2. Shews the solid part of the step out of which the scroll is formed; where *a* represents the *overfall* of the step; *b*, The thickness of the bracket, with its *mirring* to the *riser*; and, *c*, The *string-board*.

Fig. 4. Shews the scale for drawing the scroll of fig. 3.—To perform which, take the distance from 1 to the centre, in fig. 3. and set it from 1 to the centre in fig. 4.; divide that extent into three parts, then set four such parts on the upper side of the scale, and draw the line from 4 to 1; set one foot of your compasses at 4, and strike the circular line; let that be divided into 12 equal parts, and then draw lines from 4 through those divisions to the upright line.

The scale being thus made, draw the scroll of fig. 3. by it in the following manner.

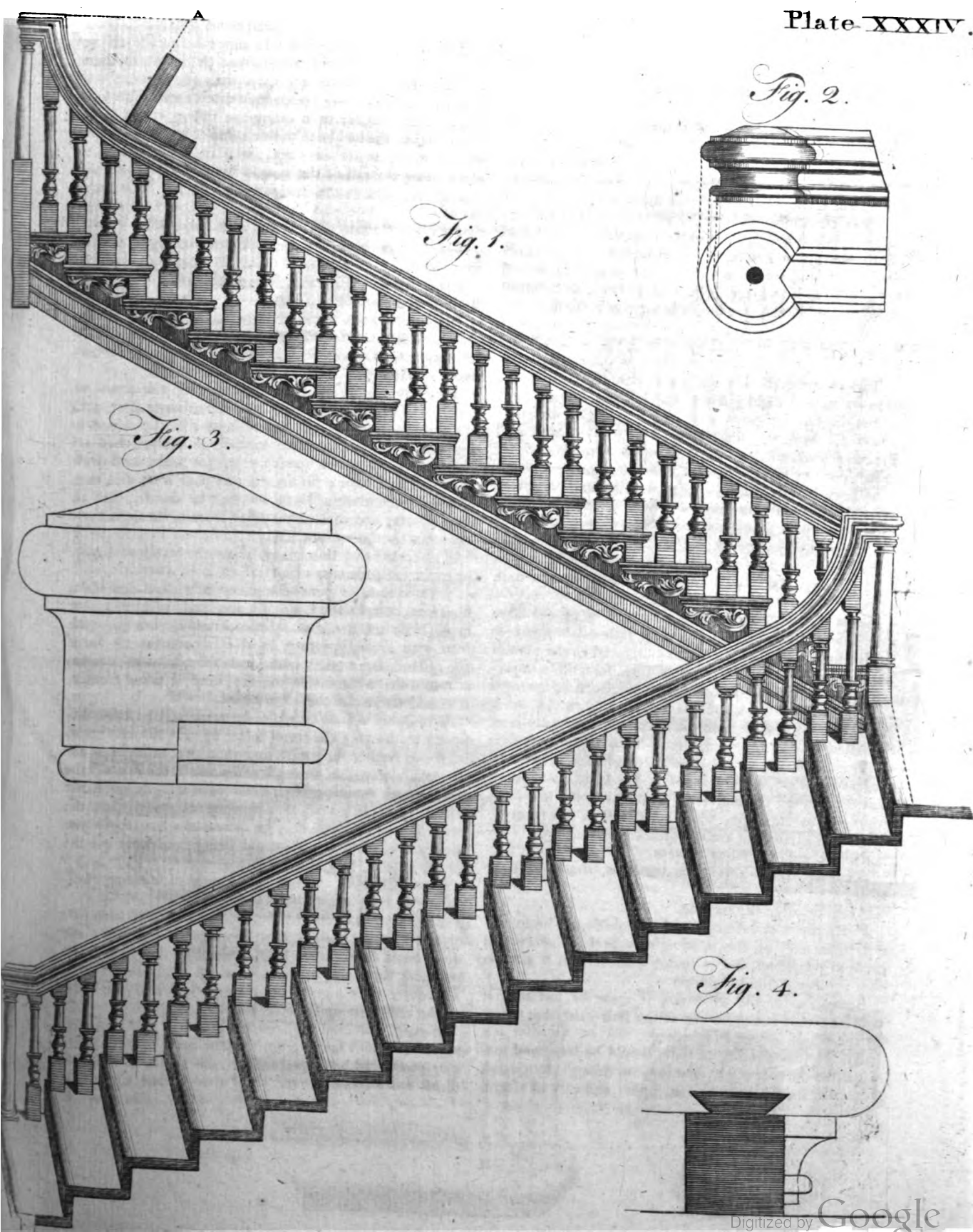
Set one foot of your compasses in 1, and describe a stroke at *c*; take the same distance, and with one foot in 2, cross the stroke at *c*; then from *c*, turn the part from 1 to 2, and proceed in the same manner; for if the distance were taken in the scale from 1 to the centre, it would strike the circle too flat; and if taken from 2, it would strike the circle too quick.

When this is well understood, there will be little difficulty in drawing the scroll below fig. 2.; which throws itself out farther in proportion than that in fig. 3.; for this will always be the case when the upper line of the scale, which consists of four divisions in fig. 4. is made but with three divisions or less; whence it appears, that the upper line of the scale may be drawn at what length you please, according as you would bring in or keep out the scroll.

Plate XXXVI. Shews the manner of squaring twist-rails.

Fig. 2. Exhibits the pitch-board, to shew what part of the step the twisted part of the rail contains; the three dotted lines drawn from the rail to the pitch-board represent the width of the rail, which is to be kept level. The dotted lines *a* and *b* shew how much half the width of the rail turns up from its first beginning to 3.

Fig. 3. Shews the same pitch-board, with the manner of the rail's turning up. If the sides of the twisted part of the rail be shaped by the rail-mould, so that they direct down to its ground-plan, that is, the upper side



*Fig. 1.*

*Fig. 2.*

*Fig. 3.*

*Fig. 4.*



Fig. 4.

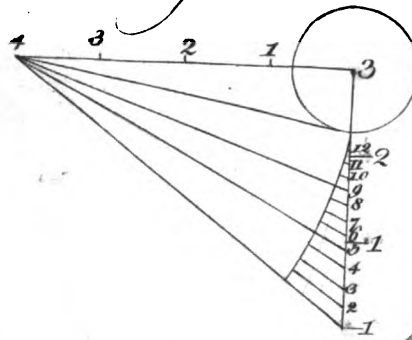


Fig. 3.

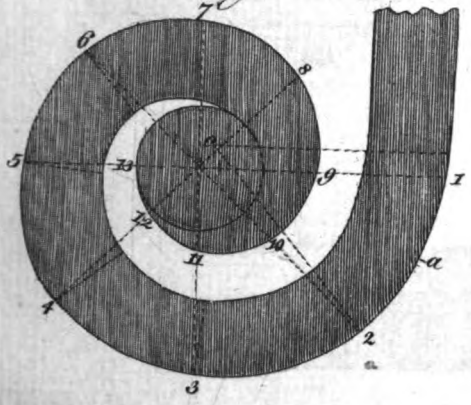


Fig. 1.

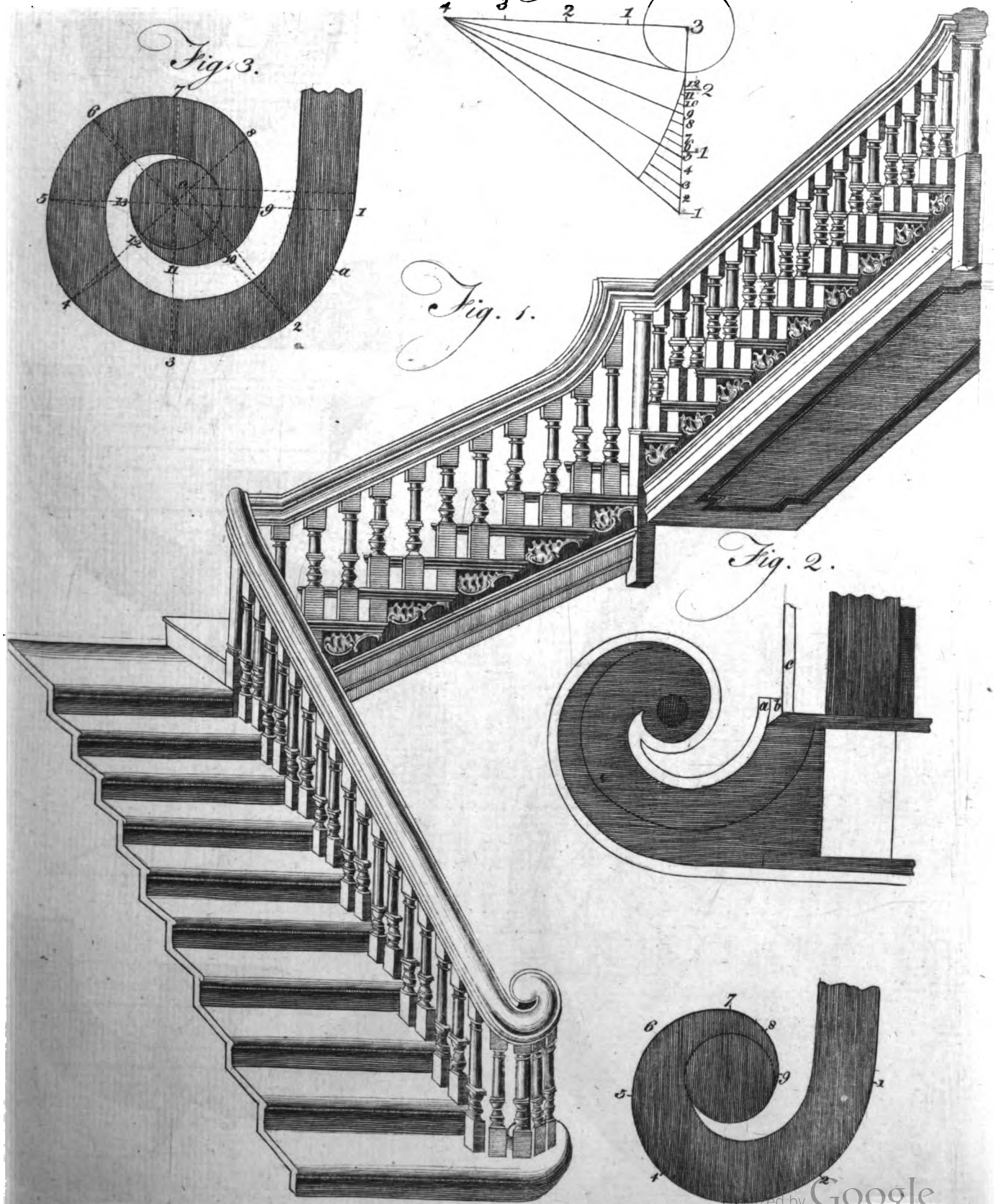


Fig. 2.

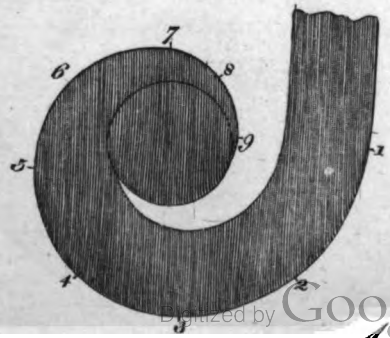
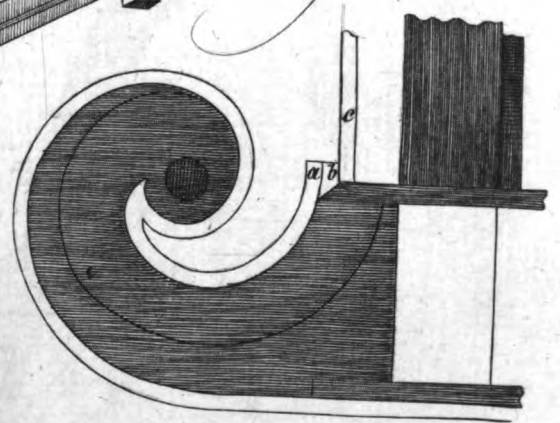




Fig. 1.

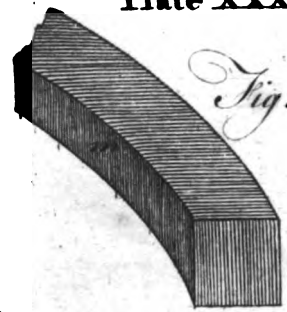


Fig. 2.

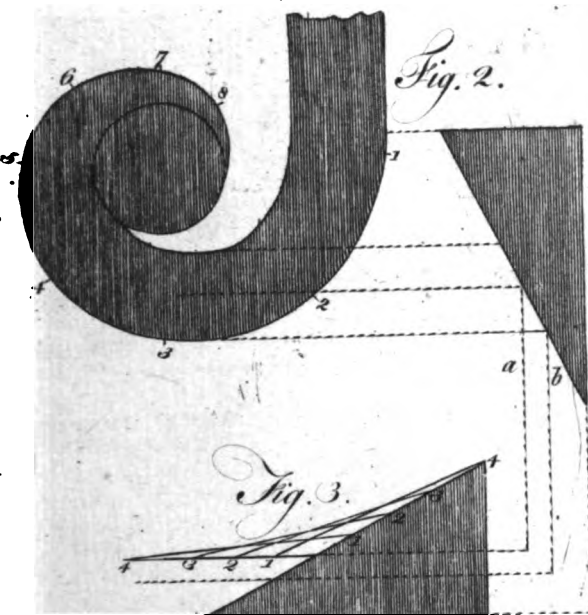


Fig. 3.



Fig. 4.

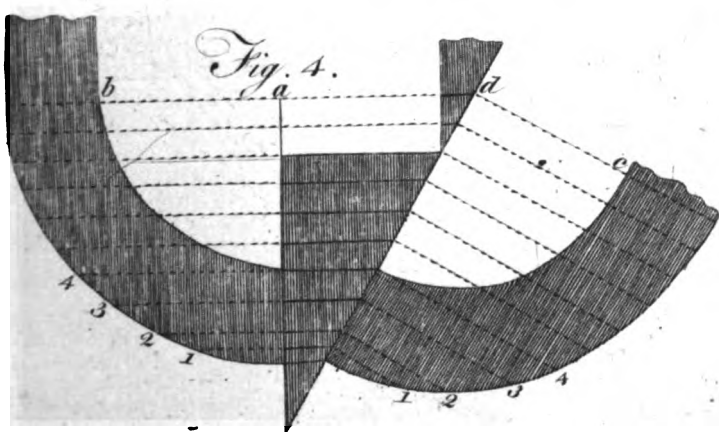


Fig. 5.

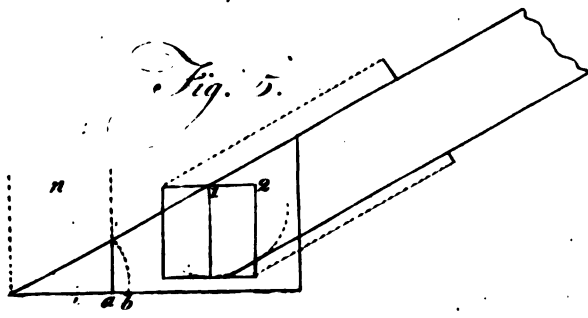


Fig. 7.

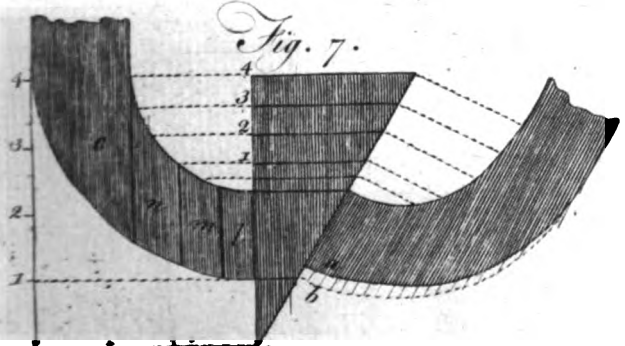
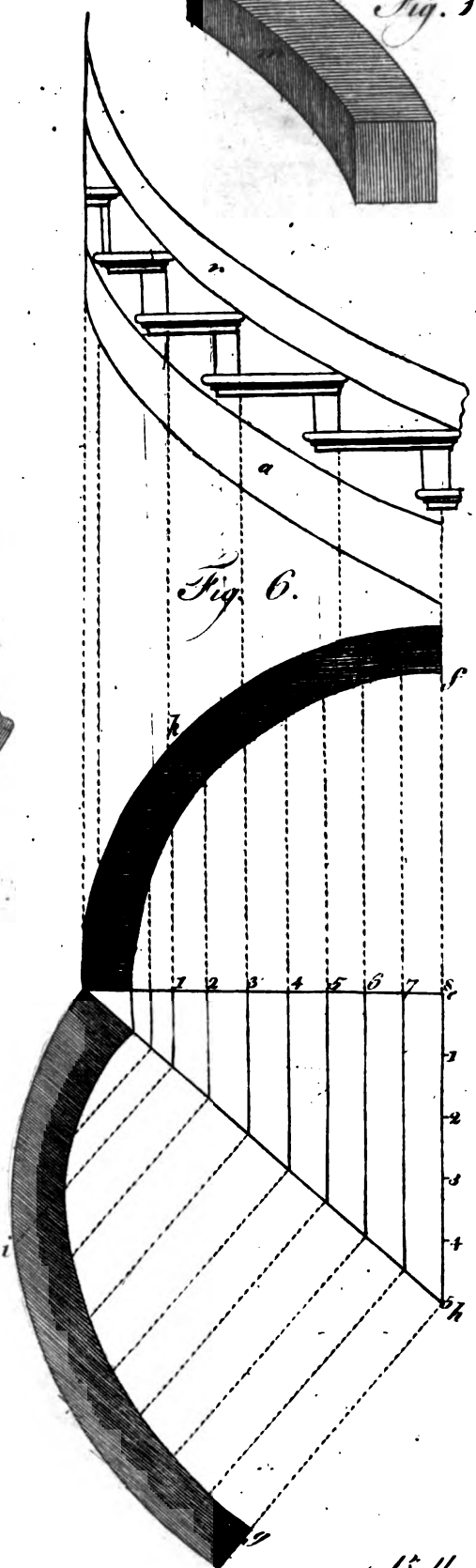


Fig. 6.

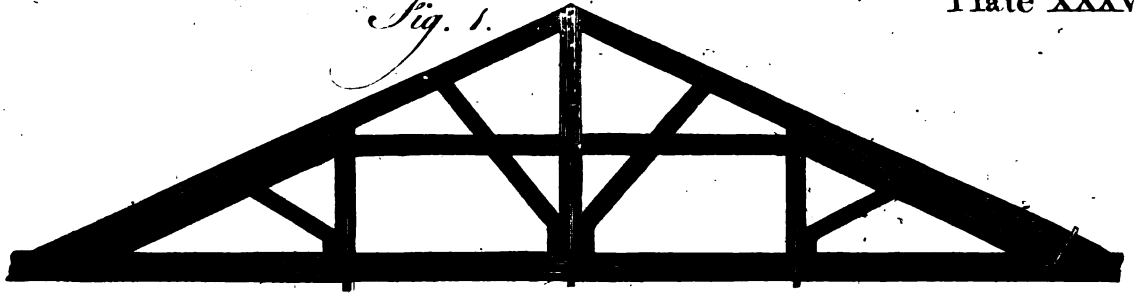




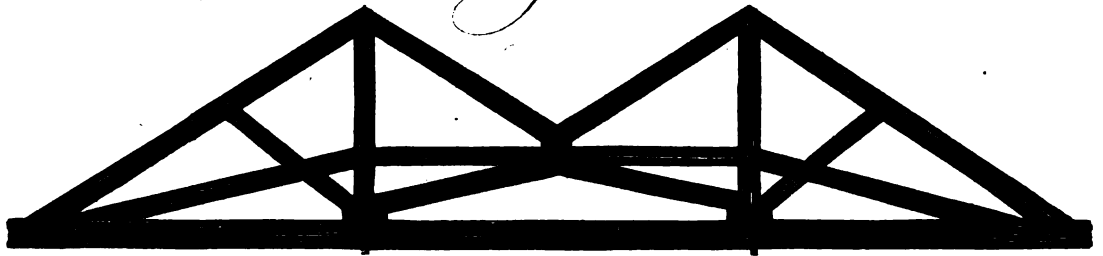




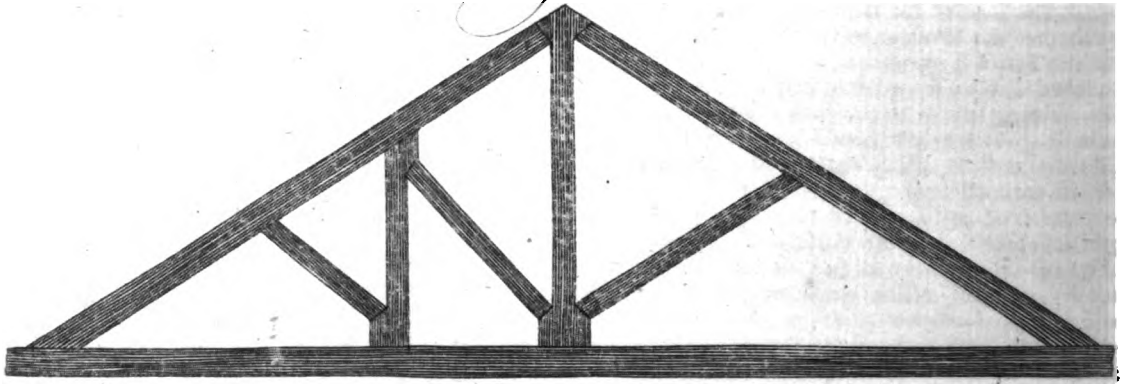
*Fig. 1.*



*Fig. 2.*



*Fig. 3.*



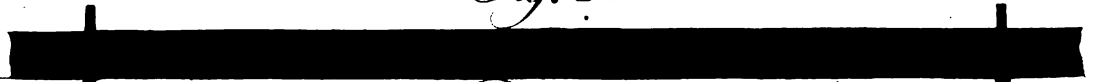
*Fig. 4.*



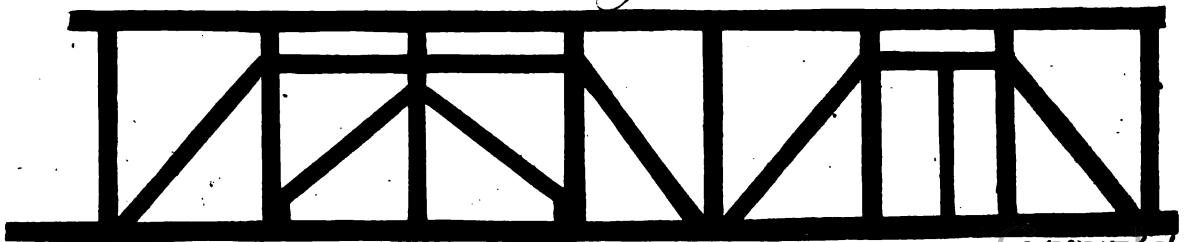
*Fig. 5.*



*b*



*Fig. 6.*



of the rail being first struck by the mould, then apply the mould to the under side, as much back as the level of the pitch-board shews, by being struck on the side of the rail, and then fig. 3. being applied to the outside of the rail, from its first twisting part to 3, will show how much wood is to be taken off.

Fig. 5. Exhibits the square of the rail, with the raking-line of the pitch-board drawn through the middle on the upper side; then draw the depth of the side of the rail parallel to this, and the dotted lines from the diagonal of the rail; these lines shew what quantity of wood will be wanting on the upper and lower sides of the rail. Set your compasses at *c*, and draw the circular stroke from the raking part of the pitch-board to *b*; take the distance *a b*, and transfer it from *a* to *b*, in fig. 7. The several distances thus found may be set at any number of places, ranging with the straight part of the rail; and it then forms the width of the mould for the twisting part of the rail.

Fig. 7. Shews the sweep of the rail. The rail cannot be fixed less than one fourth part from the nosing or front of the step.

The remaining part of the pitch-board may be divided into any number of parts, as here into four; from these divisions draw lines across the pitch-board to the raking-line; then take the distances from the ground-line of the pitch-board to the plan of the rail, and set them perpendicular from the raking-line of the pitch-board; and these divisions, when the rail is in its proper position, lie directly over the divisions on the ground-plan.

In this figure *l*, *m*, and *n*, rise as much above *o* as the dotted line in fig. 5. does above the width of the rail; and they sink as much below *o* as the other dotted line in fig. 5. falls below the width of the rail; the same thicknesses must be glued upon *o*, though the greatest part will come off in squaring. The reason of placing the letters *l*, *m*, and *n*, where they are, is, that they might not obstruct the small divisions of the rail-mould.

Fig. 4. Shews how to find the rail when it takes more than one step. The remaining part of the pitch-board is divided into four parts, as before in fig. 7. and it takes in two such parts of the next step. Draw lines from these divisions to the diagonal of the pitch-board, as in fig. 7.; then take the distance *a b*, and set it from *c* to *d*, and so proceed with the other divisions.

Another way to find the outside of the rail-mould is, to draw all the divisions across the plan of the rail; then take the distance from the ground-line of the pitch-board to 4, transfer it from the diagonal of the pitch-board to 4

on the rail; and so proceed with the other distances. Now, when the rail is put in its proper situation, *c* will be perpendicular to *b*, and all the divisions, as 1, 2, 3, 4, &c. in the rail, will be perpendicular to 1, 2, 3, 4, &c. in the ground-plan.

Fig. 6. Shews the plan of a rail of five steps.

To find the rail.—Set five divisions, as from *e* to *h*, which is the height of the five steps; draw the diagonal *b* to the plan of the rail; then take the distance *e f*, and transfer it from *g* to *b*, and proceed in the same manner with the other seven distances.

To find the width of the rail-mould.—Draw the lines across the plan of the rail, as at *k*; set that distance from the diagonal to *i*; and so proceed with the rest, as was shewn in fig. 4.

Having formed the sides of the rail perpendicular to its ground-plan, and having squared the lower end of the rail, then take a thin lath, and bend it with the rail, as is represented by *m* fig. 1.

This is the readiest method of squaring a solid rail; but if the rail be bent in the thicknesses, the nosing of the steps must be drawn upon a cylinder, or some other solid body of a sufficient width to contain the width of the rail or string-board.

*r*, Represents the depth of the rail, touching the nose of each step. Take a sufficient number of thicknesses of this width, to make the thickness of your rail; glue them all together upon your cylinder or templet, confine them till they are dry, and the rail taken off is ready squared. Proceed in the same manner with the architrave, marked *a*.

## OF ROOFS.

PLATE XXXVII. Fig. 1. Shews the form of a trussed roof, with three ring-posts, that may carry seventy feet, or upwards.

Fig. 2. Exhibits an *M* roof, capable of carrying as great an extent as the former. Indeed both these designs are capable of carrying almost any extent.

Fig. 3. Represents two different sorts of trusses.

Fig. 4. Shews the manner of piecing timber. Sometimes the joint may be extended as far as *a*, with another bolt through it. To the right is shewn a different sort of joint.

Fig. 5. Shews the manner of trussing a girder. If the trusses are full long, with the pieces *b* and *c* you may make them as light as you please.

Fig. 6. Represents the manner of trussing partitions.

## A R C

## A R C

**Military ARCHITECTURE**, the same with what is otherwise called fortification. See FORTIFICATION.

**Naval ARCHITECTURE**, the art of building ships. See SHIP-BUILDING.

**Counterfeit ARCHITECTURE**, that which consists of projectures, painted in black or white, or in colours after the manner of marble, which is also called

scene-work, in the painting of columns, &c. for the decoration of theatres.

**ARCHITECTURE**, in perspective, a sort of building, the members of which are of different modules, and diminish proportionably to their distance, in order to make the work appear longer to the view than it really is. See PERSPECTIVE.

**ARCHITALASSUS**, or admiral-shell, a synonyme of a species of *conus*. See *CONUS*.

**ARCHITRAVE**, in architecture, that part of a column which lies immediately upon the capital, being the lowest member of the entablature, and so called from its representing the principal beam in timber-buildings. See *ARCHITECTURE*.

Over a chimney, this member is called the *mantle-piece*; and over doors or windows, the *hypertyron*.

**ARCHIVOLT**, in architecture, the inner centre of an arch, or a band adorned with mouldings running over the faces of the arch-stones, and bearing upon the impost.

**ARCHIVE**, or *ARCHIVES*, an apartment in which are deposited the records, charters, and other papers of a state or community.

**ARCHMARSHAL**, the grand marshal of the empire, a dignity belonging to the elector of Saxony.

**ARCHON**, in Grecian antiquity, the chief magistrate of Athens, after the abolishing of monarchy; and also, the appellation given to several officers, both civil and religious, under the Greek empire.

**ARCHONTICI**, in church-history, a branch of Valentinians, who maintained, that the world was not created by God, but by angels called *Archontes*.

**ARCHTREASURER**, the great treasurer of the German empire, a dignity belonging to the duke of Brunswick, king of Great Britain.

**ARCHIGOVINO**, a province of Dalmatia, bounded by Bosnia, Mantenero, and the Adriatic sea; and called by the Italians *Santa Sabuta*.

**ARCILEUTO**, a lute longer and larger than ordinary.

**ARCION**, in botany, an obsolete name of the tusilago.

**ARCO**, a town of the bishopric of Trent in Italy, situated about 16 miles S. W. of Trent, in 10° 46' E. long. and 46° N. lat.

**ARCTAPELIOTES**, a term used to denote a north-east wind.

**ARCTIC**, in astronomy, an epithet given to the north pole; and likewise to a circle of the sphere, parallel to the equator, and twenty-three degrees thirty minutes distant from the north pole. See *ASTRONOMY*, and *GEOGRAPHY*.

**ARCTICA**, in ornithology, a synonyme of a species of *larus*. See *LARUS*.

**ARCTIUM**, in botany, a genus of the syngenesia polygamia equalis class. The calix is globular, squamous, and hooked at the tops. There are only two species of *arctium*, viz. the lappa, or burdock, a native of Britain; and the personata, a native of the Alps, &c. The roots and seeds of the lappa are esteemed to be diuretic and sudorific. Decoctions of the roots have of late been used in rheumatic and gouty disorders.

**ARCTOPHYLAX**, a constellation, otherwise called *Boötes*. See *BOÖTES*.

**ARCTOPUS**, in botany, a genus of the polygamia dioecia class. The umbella of the male is compound; the involucreum consists of five leaves; the corolla has five petals; the stamina are five; and two pistils: The umbella of the hermaphrodite is simple; the involucreum is divided into four parts, is spinous, large,

and contains many male flowers in the disk. There is but one species of *arctopus*, viz. the *echinatus*, a native of Ethiopia.

**ARCTOTIS**, in botany, a genus of the syngenesia polygamia necessaria class. The receptacle is bristly; the corona of the pappus is pentaphyllous; and the calix is imbricated, with the scales loose at the top. There are 11 species of *arctotis*, all of them natives of Ethiopia, or the Cape of Good Hope.

**ARCTURUS**, a fixed star of the first magnitude, in the skirt of *Boötes*.

**ARCTUS**, in astronomy, the Greek name of the ursa major and minor. See *ASTRONOMY*, and *URSA*.

**ARCUATION**, in gardening, the raising of trees by layers. See *GARDENING*.

**ARCUATION**, in surgery, denotes a distortion or incurvation of the bones, as happens in the rickets, &c.

**ARCUATIO**, a machine consisting of hoops, used in Florence by nurses, in order to prevent the child from being overlaid. Every nurse is obliged to lay her child in an *arcutio*, under the pain of excommunication.

**ARCYRIA**, in botany. See *CLATHRUS*.

**ARDASSES**, the coarsest of all the silks in Persia.

**ARDEA**, in ornithology, a genus of the order of grallæ. The general characters of this order are these: The bill is straight, sharp, long, and somewhat compressed, with a furrow that runs from the nostrils towards the point; the nostrils are linear; and the feet have four toes. This genus consists of 26 species; and under it Linnæus comprehends the *grus* or crane, the *vicinia* or stork, and the *ardea* or heron; of other authors. The first species is the *pavonina*, or crowned crane, which has an erect bristly crest, with the temples and two wattles naked. The head is black; the crest is yellowish, and tipped with black at the top; the wings are white; and the feathers of the tail black, and of an equal length. It is a native of Africa. 2. The *virgo* has long white supercilia that hang down backwards. The body is of a bluish ash-colour, and about the size of a stork; the head and prime feathers of the wings towards the points are black and pendulous; the edges are red, and the pupils are ash-coloured; behind the eyes, on both sides, there is a feathery crest, which turns backwards a considerable way, and is of a white colour: The feet are black; the beak is green at the base, yellowish in the middle, and red at the point. 3. The *canadensis*, or brown and ash-coloured crane of Edwards, is naked and papillous on the forehead; the body is ash-coloured, and the wings are of a reddish or brick-colour. 4. The *grus*, or common crane of English authors, has a naked papillous crown; the prime feathers of the wings are black; the body is ash-coloured; the prime feathers of the tail are ragged. It is a native of Europe and Africa. It winters in Lithuania, Padolia: *Trans Pentum sagat et terris immitit apricis*. Virg. This bird commonly rests upon one foot. 5. The *americanus*, or hooping crane of Edwards, is a native of America: The crown of the head and temples are naked and papillous; the forehead, nape of the neck, and prime wing-

wing-feathers are black; but the body is white: The under part of the head, as far as the lower chap, is red; the beak is yellowish, and jagged at the point; the feet are red, and the prime tail-feathers white. 6. The Antigone, or greatest Indian crane of Edwards, has a naked head, and papillous collar; the body is ash-coloured, and the prime wing-feathers black. Behind the eyes, there is a small white spot, and the crown of the head is also white. The breast is of a greenish yellow colour; the feet are red, and the prime tail-feathers ash-coloured. It is a native of Asia. 7. The ciconia, or white stork of Ray, has naked eye-balls, and black prime wing-feathers. The skin below the feathers, as also the beak, feet, and claws, are of a blood-colour. It is a native of Europe, Asia, and Africa; but is seldom or never to be met with in Italy. The ciconia feeds upon amphibious animals. It is such an enemy to serpents, that it is reckoned almost a crime to kill a stork. From this favourable treatment, they are seen in Holland and the Low Countries walking unconcerned in the middle of the streets. Storks are birds of passage; they spend the summer in Europe, and disappear all at once, and go off to Egypt, Ethiopia, &c. before winter, and do not return till about the middle of March. 8. The nigra, or black stork of Willoughby, has naked orbits, and the breast and belly are white; the body is black; the feet and orbits are blood-coloured. It inhabits the northern parts of Europe. 9. The nycticorax, or lesser ash-coloured heron of Ray, has a crest, consisting of three straight horizontal white feathers, on the back part of the head; the back is greenish, and the belly yellow. It inhabits the southern parts of Europe. 10. The purpurea, or common heron of English authors, has a crest, with two long green feathers hanging down from the back part of the head; the body is of an olive-colour, and purple below; the head is of a shining green colour. It is a native of the East. 11. The cinerea, or ash-coloured heron, has a smooth black head, a bluish back, white belly, and oblong black spots on the breast. It is a native of Europe. Great numbers of them together build their nests in trees. They are said to fly very high before storms. 12. The major has a black crest depending from the back part of the head, an ash-coloured body, and a black line and belt on the neck and breast. It is a native of Europe. 13. The garzetta is crested behind; the body is white, the beak black, and the feet greenish. It is a native of the East. 14. The cocoi has an ash-coloured crest hanging down from the back part of the head; the whole body is ash-coloured. It is a native of Cayenne. 15. The herodias is crested behind, has a dusky-coloured back, reddish thighs, and the breast speckled with oblong black spots. It is a native of America. 16. The violacea has a white crest; the body is variegated with black and white, and bluish below. It is a native of America. 17. The carulea has a crest behind, and a bluish body. It is a native of N. America. 18. The hudsonia has a black crest on the top of the head; the body is dusky-coloured, and white below. It frequents Hudson's Bay. 19. The striata has a small crest on the back-part of the head; the back is of a hoary grey colour, and ash-coloured be-

low; the long wing-feathers are tipped with white. It is a native of Surinam. 20. The virescens has a small crest on the back part of the head, a green shining back, and dusky-coloured breast. It is a native of America. 21. The stellaris, or bittern, has a smooth head; it is variegated through the whole body with dark-coloured spots of different figures and sizes. It is a native of Europe, and inhabits chiefly the fen-countries. It is met with skulking among the reeds and sedge, and its usual posture is with the head and neck erect, and the beak pointed directly upwards. It will suffer persons to come very near it without rising; and has been known to strike at boys and at sportsmen, when wounded and unable to make its escape. It flies principally about the dusk of the evening, and then rises in a very singular manner, by a spiral ascent, till it is quite out of sight. It makes a very strange noise when it is among the reeds, and a different and very singular one as it rises on the wing in the night. 22. The grisea has a smooth dusky head; the body is tawny above, and white below; and the prime wing-feathers have a black spot at the points. It is a native of the East. 23. The brasiliensis has a smooth head; the body is blackish, with yellow spots; and the prime feathers of the wings and tail are greenish. It is a native of America. 24. The alba has a smooth head, a white body, a yellow beak, and black feet. It is a native of Europe. 25. The æquinoctialis has a smooth head, and a white body. It is a native of America. 26. The minuta has a smooth head, a dark-coloured body, and a yellowish belly. It is about the size of the tardus, and is a native of Switzerland and the East.

ARDENBURG, a fortified town of Dutch Flanders, situated about 12 miles N. E. of Bruges, in  $3^{\circ} 20'$  E. long. and  $51^{\circ} 15'$  N. lat.

ARDENNE, a forest in Germany, lying between Thionville and Liege.

ARDEVIL, or ARDEBIL, the burying-place of some of the ancient kings of Persia, situated in  $64^{\circ} 20'$  E. long. and  $36^{\circ}$  N. lat.

ARDMAGH, in geography. See ARMAGH.

ARDOR-VENTRICULI, the same with the heart-burn.

ARDRES, a town of the province of Picardy in France, situated about 10 miles south of Calais, in  $2^{\circ}$  E. long. and  $50^{\circ} 45'$  N. lat.

ARDRES, or ARDRA, is also the capital of a country on the slave-coast of Guinea in Africa, situated near the river Lagos, in  $4^{\circ}$  E. long. and  $5^{\circ}$  N. lat.

ARE, in music. See ALAMIRE.

AREA, in geometry, denotes the superficial content of any figure. See GEOMETRY.

AREA, among physicians, the same with alopecia. See ALOPECIA.

AREBON, a town of Guinea in Africa, situated at the mouth of the river Formosa, in  $5^{\circ}$  E. long. and  $3^{\circ}$  N. lat.

ARECA, in botany, a genus of the order of palmæ pennatifolia. The male has no calix, but three petals, and nine stamens; the female has no calix; the corolla.

corolla has three petals, and the calix is imbricated. There is only one species, *viz.* the cathecu, a native of India.

**AREMBERG**, a city of Germany, situated about 25 miles south of Cologne, in  $6^{\circ} 25'$  E. long. and  $50^{\circ} 30'$  N. lat.

**ARENA**, in natural history. See **SAND**.

**ARENA**, in Roman antiquity, a place where the gladiators fought; so called from its being always strewed with sand, to conceal from the view of the people the blood spilt in the combat.

**ARENARIA**, or chickweed, in botany, a genus of the decandria trigynia class. The calix has five open leaves; the petals are five, and entire; the capsule is unilocular, and contains many seeds. There are 17 species of arenaria, only 7 of which are natives of Britain, *viz.* the peploides, or sea-chickweed; the trinervia, or plantain-leaved chickweed; the serpyllifolia, or least chickweed; the saxatilis, or mountain-chickweed; the laricifolia, or larch-leaved chickweed; the tenuifolia, or fine-leaved chickweed; and the rubra, or purple-flowered chickweed.

**ARENATION**, a kind of dry bath, wherein the patient sits with his bare feet on hot sand.

**AREOLA**, among anatomists, the coloured circle surrounding the nipple of the breast.

**AREOPAGUS**, a sovereign tribunal at Athens, famous for the justice and impartiality of its decrees, to which the gods themselves are said to have submitted their differences.

Authors are not agreed about the number of judges that composed this august court; some reckon thirty-one; others, fifty-one; and others, five hundred. In effect, their number seems not to have been fixed, but to have been more or less in different years. At first, this tribunal consisted only of nine persons, who had all discharged the office of Archons, had acquitted themselves with honour in that trust, and had likewise given an account of their administration before the Logists, and undergone a rigorous examination. Their salary was equal, and paid out of the treasury of the republic; they had three oboli for each cause. The Areopagites were judges for life; they never sat in judgment but in the open air, and that in the night-time, to the intent that their minds might be the more present and attentive, and that no object of pity or aversion might make any impression on them; and all the pleadings before them were to be in the simplest and most naked terms. At first they took cognisance of criminal causes only, but in course of time their jurisdiction became of great extent.

Mr Spon, who examined the antiquities of that illustrious city, found some remains of the Areopagus still existing in the middle of the temple of Theseus, which was heretofore in the middle of the city, but is now without the walls. The foundation of the Areopagus is a semicircle, with an esplanade of 140 paces round it, which properly made the hall of the Areopagus. There is a tribunal cut in the middle of a rock, with seats on each side of it, where the Areopagites sat exposed to the open air. It is very uncer-

tain when this court was instituted, since Demosthenes himself is at a loss upon the point: Some think that it was instituted by Solon; but others carry it much higher, and assert it to have been established by Cecrops, about the time that Aaron died.

**AREQUIPPA**, a city of Peru, in S. America, situated in  $73^{\circ}$  W. lon. and  $17^{\circ}$  S. lat.

**AREHA**, in botany, a genus of the pentandria monogynia class. The corolla is divided into five parts; the tube of the corolla is ovated; and the capsule is globular, and consists of but one cell. There is only one species, *viz.* the alpina.

**ARETHUSA**, in botany, a genus of the gynaecia diandria class. The generic character is taken from the nectarium, which is tubular, situated at the bottom of the corolla; and the inferior labium of it is fixed to the stylus. There are four species of the arethusa, all natives of America, except the capensis, which is only found at the Cape of Good Hope.

**ARGEMONE**, in botany, a genus of the polyandria monogynia class. The corolla consists of six petals; the calix of three leaves; and the capsule is semi-valved. There are three species of argemone, none of which are natives of Britain. They are all a kind of poppies.

**AREZZO**, a city of Tuscany in Italy, situated in  $13^{\circ} 15'$  E. long. and  $43^{\circ} 15'$  N. lat.

**ARGEA**, or **ARGEI**, in Roman antiquity, thirty human figures, made of rushes, thrown annually by the priests or vestals into the Tiber, on the day of the ideas of May.

**ARGENT**, in heraldry, the white colour in the coats of gentlemen, knights, and baronets. See **HERALDRY**.

**ARGENTAN**, a city of France, in the Lower Normandy, upon the Orne, in  $25'$  E. long. and  $48^{\circ} 34'$  lat.

**ARGENTARIA creta**, pure white earth, found in Prussia, and much esteemed for cleaning plate.

**ARGENTIERE**, a small island in the Archipelago, situated about 60 miles east of Morea, in  $25^{\circ}$  E. long. and  $37^{\circ}$  N. lat.

**ARGENTIERE** is also the name of a small town of Languedoc in France, in  $4^{\circ}$  E. long. and  $44^{\circ} 30'$  N. lat.

**ARGENTINA**, in ichthyology, a genus of fishes belonging to the order of abdominales. The generic characters are these: The teeth are in the tongue as well as the jaws; the branchiostege membrane has eight radii or rays; the anus is near the tail; and the belly-fins consist of many rays. There are two species of argentina, *viz.* 1. The sphyæna has 15 rays in the fin at the anus; the air-bladder of this species is conical on both sides, and shines like silver: According to Mr Ray, false pearls are sometimes made of it. 2. The carolina has likewise 15 rays in the fin near the anus; the tail is forked, and the lateral lines are freight. It inhabits the fresh waters of Carolina.

**ARGENTON**, a town of France, situated about forty-five miles south-west of Bourges, in  $1^{\circ} 35'$  E. long.  $46^{\circ} 40'$  N. lat.

**ARGENTUM**. See **SILVER**.

**ARGILLA**,

**ARGILLA**, clay, in natural history. See **CLAY**.  
**ARGO**, in astronomy, a constellation of fixed stars in the southern hemisphere; whose number of stars, in Ptolemy's catalogue, is eight; in Tycho's, eleven; and in Mr Flamsteed's, twenty-five. See **ASTRONOMY**.  
**ARGONAUTA**, the name of a genus of shell-fish belonging to the order of vermes testacea. The shell consists of one spiral involuted valve. There are two species of argonauta, viz. The argo with a subdentated carina, which is found in the Mediterranean and Indian oceans. This is the famous nautilus of other authors. It lies on the surface of the water, and extends an exceeding thin membrane, which it uses in some measure both as sails and oars; and in this manner it swims from one place to another. 2. The cymbium with a blunt plaited carina. This species is very small, and is found in the Mediterranean.  
**ARGONAUTS**, in Grecian antiquity, a company of illustrious Greeks, who embarked along with Jason, in the ship Argo, on an expedition to Colchis, with a design to obtain the golden fleece.  
**ARGOS**, a sea-port town of European Turkey, in the Morea, situated on the bay of Napoli de Romania, in 23° E. long. and 37° 30' N. lat.  
**ARGUIN**, an island on the coast of Negritia. It lies on the Atlantic Ocean, about 20' N. lat.  
**ARGUMENT**; in rhetoric and logic, an inference drawn from premises, the truth of which is indisputable, or at least highly probable. See **LOGIC**.  
**ARGUMENT**, in astronomy, denotes a known arch, by means of which we seek another one unknown.  
**ARGUMENT**, in matters of literature, denotes also the abridgment or heads of a book, history, comedy, chapter, &c. See **SYLLABUS**.  
**ARGUN**, a river of Tartary in Asia, serving as a boundary between the Chinese and Russian empires.  
**ARGUN** is also a city of Asiatic Tartary, situated on the above river, in 104° E. long. and 51° 30' N. lat.  
**ARGUS-SHELL**, a species of porcelain-shell, beautifully variegated with spots, resembling in some measure those in a peacock's tail.  
**ARGYLESHIRE**, a county of Scotland, lying westward of Glasgow, and comprehending the countries of Lorn, Cowal, Knapdale, Kintyre, together with the islands Mull, Jura, Ista, &c. It gives the title of duke to the noble family of Campbell.  
**ARGYROPOEIA**, among alchemists, a pretended art of transmuting or changing other metals into silver.

**ARHUSEN**, a city of Jutland in Denmark, situated at the entrance of the Baltic sea, in 10° 20' E. long. and 56° N. lat.  
**ARIANO**, a town of the kingdom of Naples, and province of Principata, situated about 15 miles east of Benevento, in 15° 35' E. long. and 41° 16' N. lat.  
**ARIANS**, in church-history, a sect of ancient heretics, who denied the three persons in the Holy Trinity to be of the same essence, and affirmed Christ to be a creature.  
**ARICA**, a sea-port town of Peru in South America, situated on the Pacific Ocean, in 70° 20' W. long. and 18° 20' S. lat.  
**ARIDAS**, a kind of taffety, manufactured in the E. Indies, from a shining thread which is got from certain herbs, whence they are styled *aridas of herbs*.  
**ARIDULLAM**, in natural history, a kind of zarnich found in the E. Indies. See **ZARNICH**.  
**ARIES**, in zoology. See **OVIS**.  
**ARIES**, in astronomy, a constellation of fixed stars, drawn on the globe, in the figure of a ram. It is the first of the twelve signs of the zodiac, from which a twelfth part of the ecliptic takes its denomination. See **ASTRONOMY**, *Of the fixed stars*.  
**ARISARUM**, in botany. See **ARUM**.  
**ARISH**, a Persian long measure, containing about 38 English inches.  
**ARISI**, the Indian name for the plant which produces the rice. See **ORYSA**.  
**ARISTA**, or **AWN**, among botanists, a long needle-like beard, which stands out from the husk of a grain of corn, grass, &c.  
**ARISTIDA**, in botany, a genus of the triandria digynia class. The calix has a double valve; the corolla has one valve, and three awns at the points. There are 3 species of aristida, viz. the adscensionis, a native of the island of Ascension; the Americana, a native of Jamaica; and the plumosa, a native of America.  
**ARISTOCRACY**, a form of government where the supreme power is vested in the principal persons of the state. See **GOVERNMENT**.  
**ARISTOLOCHIA**, in botany, a genus of the gynandria hexandria class. It has no calix; the corolla consists of one entire petal; and the capsule, which is below the flower, has 6 cells. There are 21 species of aristolochia, none of which are natives of Britain.  
**ARISTOLUS**, an obsolete name of a species of clupea. See **CLUPEA**.

## A R I T H M E T I C K.

**ARITHMETICK** is a science which explains the properties of numbers, and shews the method or art of computing them.  
 Vol. I. No. 16.

We have very little intelligence about the origin and invention of arithmetick; but probably it must have taken its rise from the introduction of commerce, and consequently

quently be of Tyrian invention. From Asia it passed into Egypt, where it was greatly cultivated. From thence it was transmitted to the Greeks, who conveyed it to the Romans with additional improvements. But, from some treatises of the ancients remaining on this subject, it appears that their arithmetick was much inferior to that of the moderns.

**NUMBER**, which is the object of arithmetick, is that which answers directly to the question, How many? and is either an unit, or some part or parts of an unit, or a multitude of units.

To a person having the idea of number in his mind, the following questions naturally occur, *viz.* 1. How is such a number to be expressed or written? Hence we have Notation. 2. What is the sum of two or more numbers? Hence Addition. 3. What is the difference of two given numbers? Hence Subtraction. 4. What will be the result or product of a given number repeated or taken a certain number of times? Hence Multiplication. 5. How often is one given number contained in another? Hence Division.

These five, *viz.* Notation, Addition, Subtraction, Multiplication, and Division, are the chief parts, or rather the whole of arithmetic; as every arithmetical operation requires the use of some of them, and nothing but a proper mixture of them is necessary in any operation whatever; and, by an Arabic term, these are called the *algorithm*.

## CHAP. I. NOTATION.

**NOTATION** is that part of arithmetic which explains the method of writing down, by characters or symbols, any number expressed in words; as also the way of reading or expressing, in words, any number given in characters or symbols. But the first of these is properly notation, and the last is more usually called *numeration*.

The things then proper to be comprised in this chapter are, 1. The figural notation. 2. Numeration, or the way of reading numbers. 3. Descriptions of the kinds or species of numbers.

### I. Figural Notation.

An unit, or unity, is that number by which any thing is called one of its kind. It is the first number; and if to it be added another unit, we shall have another number called *two*; and if to this last another unit be added, we shall have another number called *three*; and thus, by the continual addition of an unit, there will arise an infinite increase of numbers. On the other hand, if from unity any part be subtracted, and again from that part another part be taken away, and this be done continually, we shall have an infinite decrease of numbers. But though number, with respect to increase and decrease, be infinite, and knows no limits; yet ten figures, variously combined or repeated, are found sufficient to express any number whatsoever. These, with

the method of notation by them, were originally invented by some of the eastern nations, probably the Indians; afterwards improved by the Arabians; and at last brought over to Europe, particularly into Britain, betwixt the tenth and twelfth century. From the ten fingers of the hands, on which it hath been usual to compute numbers, figures were called *digits*. Their form, order, and value, are as follows:

1 One, an unit, or unity, 2 two, 3 three, 4 four, 5 five, 6 six, 7 seven, 8 eight, 9 nine, 0 cipher, nought, null, or nothing. Of these, the first nine, in contradistinction to the cipher, are called *significant figures*.

The value of the figures now assigned is called their *simple value*, as being that which they have in themselves, or when they stand alone. But when two or more figures are joined as in a line, the figures then receive also a local value from the place in which they stand, reckoning the order of places from the right-hand towards the left, thus,

<i>&amp;c.</i>	Twelfth place.	Eleventh place.	Tenth place.	Ninth place.	Eighth place.	Seventh place.	Sixth place.	Fifth place.	Fourth place.	Third place.	Second place.	First place.
	7	7	7	7	7	7	7	7	7	7	7	7

A figure standing in the first place has only its simple value; but a figure in the second place has ten times the value it would have in the first place; and a figure in the third place has ten times the value it would have in the second place; and universally a figure in any superior place has ten times the value it would have in the next inferior place.

Hence it is plain, that a figure in the first place simply signifies so many units as the figure expresses; but the same figure advanced to the second place will signify so many tens; in the third place, it will signify so many hundreds; in the fourth place, so many thousands; in the fifth place, so many ten thousands; in the sixth place, so many hundred thousands; and in the seventh place, so many millions, &c. Thus, 7, in the first place, will denote seven units; in the second place, seven tens; or seventy; in the third place, seven hundred; in the fourth place, seven thousand, &c.

Every three places, reckoning from the right-hand, make a half period; and the right-hand figures of these half-periods are termed *units* and *thousands* by turns; the middle figure is always tens, and the left-hand figure always hundreds.

Two half-periods, or six places, make a full period; and the periods, reckoning from the right-hand towards the left, are titled as follows, *viz.* the first is the period of *units*; the second, that of *millions*; the third is titled *bimillions*, or *billions*; the fourth, *trimillions*, or *trillions*; the fifth, *quadrillions*; the sixth, *quintillions*; the seventh *sextillions*; the eighth, *septillions*; the ninth, *octillions*; the tenth, *nonillions*, &c.

Half-periods are usually distinguished from one another by a comma, and full periods by a point or colon; as in the following

TABLE.



T A B L E.

3d Period.			2d Period.			1st Period.		
Billions.			Millions.			Units.		
Hundred thousands.	Ten thousands.	Hundreds.	Hundred thousands.	Ten thousands.	Hundreds.	Hundred thousands.	Ten thousands.	Hundreds.
Tens.	Units.		Tens.	Units.		Tens.	Units.	
8	1	3, 7	0	0	2	3	7, 8	9
						4	6	7
							8	0
							4	0

The table may be expressed in a more concise form thus,

3.			2.			1. Per.		
Billions.			Millions.			Units.		
8	1	3, 7	0	0	2	3	7, 8	9
						4	6	7
							8	0
							4	0

From the table it is obvious, that though a cipher signify nothing of itself, yet it serves to supply vacant places, and raises the value of significant figures on its left hand, by throwing them into higher places. Thus, in the first period, by a cipher's filling the place of units, the figure 4 is thrown into the place of tens, and signifies forty. But a cipher does not change the value of a significant figure on its right-hand. Thus, 07, or 007, is the same as 7.

II. Numeration.

NOTATION and numeration are so nearly allied, that he who understands the one cannot fail soon to acquire the other. The method of reading numbers, expressed by figures, may be easily learned from the table of the figural notation; in which observe the following

RULE. Beginning at the left hand, and reading toward the right; to the simple value of every figure join the name of its place, and conclude each period by expressing its title, every where omitting the ciphers.

III. Descriptions of the kinds or species of numbers.

1. An *integer*, or *whole number*, is an unit, or any multitude of units; as 1, 7, 48, 100, 125.
2. A *fraction*, or *broken number*, is any part or parts of an unit; and is expressed by two numbers, which are separated from one another by a line drawn betwixt them; the under number being called the *denominator*, and the upper one the *numerator*, of the fraction; as  $\frac{1}{2}$ ,  $\frac{3}{4}$ ,  $\frac{5}{10}$ .
3. A *mixt number* is an integer with a fraction joined to it; as  $4\frac{1}{2}$ ,  $7\frac{3}{4}$ ,  $48\frac{1}{2}$ .
4. A number is said to *measure* another number, when it is contained in that other number a certain number of times, or when it divides that other number without any remainder. Thus, 3 measures 6, 9, or 12.
5. An *even number* is that which is measured by 2, or which 2 divides without any remainder; as 2, 4, 6, 8, 10, 12.

6. An *odd number* is that which 2 does not measure, or which cannot be divided by 2, without a remainder; as 1, 3, 5, 7, 9, 11, 13.

7. A *prime number* is that which unity, or itself, only measures; as 3, 5, 7, 11, 13, 17, 19.

8. A *composite number* is that which is measured by some other number than itself, or unity; as 12, which is measured by 2, 3, 4, or 6.

9. Numbers are called *prime* to one another, when unity only measures them. Thus 13 and 36 are prime to one another; for no number, except unity, measures both.

10. Numbers are called *composite* to one another, when some number, besides unity, measures them. Thus 12 and 18 are composite to one another; for 3 or 6 measures both of them.

11. A number which measures another is called an *aliquot part* of that other. Thus 6 is an aliquot part of 18, and 3 of 12, and 5 of 20.

12. The number measured, or which contains the aliquot part a certain number of times, is called a *multiple* of that *aliquot part*. Thus 18 is a multiple of 6, and 12 of 3.

13. A number is called an *aliquant part* of another, when it does not divide that other without a remainder. Thus 7 is an aliquant part of 24.

14. Two, three, or more numbers, which, multiplied together, produce another number, are called the *component parts* of the number produced. Thus 3 and 4, 2 and 6, are the component parts of 12; and 2, 3, and 4, are the component parts of 24.

15. The product of a number multiplied into itself is called the *square*, or *second power*, of that number; and the number itself is in this case called the *root*. And if the square be multiplied into the root, the product is called the *cube*, or *third power*, of that number. And if the cube be multiplied into the root, the product thence arising is called the *biquadrate*, or *fourth power*, &c.

CHAP. II. ADDITION.

ADDITION is the collecting of two or more numbers into one sum or total.

I. Addition of Integers.

RULE I. Set figures of like places under other, viz. units under units, tens under tens; &c.

II. Beginning at the lowest place, set down the right-hand figures of the sum of every column, and carry the rest as so many units to the next superior place.

EXAMP. I. Because similar or like things only can be added, place the numbers as directed in Rule I. viz.

units under units, tens under tens, &c. as in the margin: Then beginning at the lowest place,	453
viz. that of units; say, 4 units and 3 units make	234
7 units, which set below in the place of units;	<hr/>
then 3 tens and 5 tens make 8 tens, which set below in the place of tens; then 2 hundreds and 4	687
hundreds make 6 hundreds, which set below in the place	<hr/>

of

of hundreds, and you will find the sum or total to be 687.

EXAMP. II. Having placed the numbers, units under units, &c. as in the margin, say 2 and 1 make 3, and 3 make 6, and 4 make 10; which being just 1 ten, and nothing over, set the right-hand figure 0 in the place of units; and because ten in any lower place makes but one in the next superior place, carry 1 ten, as directed in Rule II. saying, 1 ten, collected out of the units, and 6 tens, make 7 tens, and 4 make 11, and 0 makes but still 11, and 7 make 18; here again set down the right-hand figure 8, in the place of tens, and carry the remaining figure 1, being 1 hundred, to the next place, viz. that of hundreds; and having in like manner added up this column, the amount is 31; set down the right-hand figure 1 in the place of hundreds, and carry the remaining figure 3 to the next place or column; which being also added, amounts to 24; set the right-hand figure 4 below, in its proper place, and the remaining figure 2, which belongs to the next place, set on the left hand, there being no figure in the next place to which it can be carried. So the sum or total is 24180.

II. Addition of the parts of integers, such as shillings, pence, farthings, ounces, &c.

RULE I. Place like parts under other; viz. farthings under farthings, pence under pence, &c.

II. Begin at the lowest of the parts, and carry according to the value of an unit of the next superior denomination; viz. for every four in the sum of farthings carry 1 to the pence, and for every twelve in the pence carry 1 to the shillings, &c.

III. If you carry at 20, 30, 40, 60, or any just number of tens, as in adding shillings, degrees, poles, minutes, seconds, &c. proceed with the column of units as in addition of integers, and from the sum of the column of tens carry 1 for every two, or 1 for every three, &c. according as 20 or two tens, thirty or three tens, &c. make an unit of the next superior denomination. The reason appears plain in the following operations.

I. M O N E Y.

T A B L E.

4 farthings	} make	{	1 penny
12 pence			1 shilling
20 shillings			1 pound.

Marked thus.

<i>l.</i>	<i>s.</i>	<i>d.</i>	<i>f.</i> or <i>q.</i>
1	= 20	= 240	= 960

Note, The above mark signifies equal to.

*l.* is put for *libra*, a pound; *d.* for *denarius*, a penny; and *q.* for *quadrans*, a fourth-part; but *f.* is now the more usual mark for farthings.

That the learner may proceed in addition of money with the greater ease, it will be proper he get the following table by heart.

M O N E Y - T A B L E.

<i>f.</i>	<i>d.</i>	<i>s.</i>	<i>s.</i>	<i>l.</i>
4 = 1	12 = 1	20 = 1		
8 = 2	24 = 2	40 = 2		
12 = 3	36 = 3	60 = 3		
16 = 4	48 = 4	80 = 4		
20 = 5	60 = 5	100 = 5		
24 = 6	72 = 6	120 = 6		
28 = 7	84 = 7	140 = 7		
32 = 8	96 = 8	160 = 8		
36 = 9	108 = 9	180 = 9		
40 = 10	120 = 10	200 = 10		

EXAMP. Having, according to Rule I. placed like parts under other, viz. farthings under farthings, pence under pence, &c. and in each of these denominations, units under units, tens under tens, as in the margin; begin with the lowest of the parts, viz. the farthings; and say, 2 farthings and 1 farthing make 3 farthings, and 2 make 5, and 3 make 8; which, by the money-table, is 2 pence, or 2 pence, and nothing over; wherefore place 0 below in the place of farthings, or rather leave that place blank, and carry 2 pence to the place of pence, as directed in Rule II, saying, 2 pence, collected out of the farthings, and 9 make 11, and 8 make 19, and 1 (passing the 0) make 20; to this sum of units add the tens. Thus, 20 and 1 ten make 30, and 1 ten more make 40 pence; which, by the money-table, is 3 twelves, or 3 shillings, and 4 pence over; these 4 pence set below in the place of pence, and carry 3 shillings to the place of shillings. Thus, 3 shillings, collected out of the pence, and 1 shilling make 4, and 7 make 11, and 9 make 20, and 8 make 28; and because in shillings we carry at a just number of tens, viz. at 20, set the right-hand figure 8 below in the place of units, as directed in Rule III. and carry the 2 tens to the place of tens. Thus 2 tens collected out of the units, and 1 ten make 3 tens, and 1 make 4, and 1 make 5 tens, or 2 twenties, and 1 ten over; and because 2 tens, or 1 twenty, make an unit in the next place, viz. that of pounds, set the 1 ten below in the place of tens, and carry the 2 twenty shillings, or 2 pounds, to the place of pounds; which, being integers, are added as taught in addition of integers.

(10)	(20)	(12)	(4)
<i>L.</i>	<i>s.</i>	<i>d.</i>	<i>f.</i>
74	18	11	3
96	9	10	2
58	17	8	1
63	11	9	2
<hr/>			
293	18	4	

It is usual to subjoin the farthings to the pence by way of fraction, as in the margin, where the former example is transcribed in this form for the learner's instruction; in which  $\frac{1}{4}$  denotes one farthing,  $\frac{1}{2}$  two farthings, and  $\frac{3}{4}$  three farthings.

293 18 4

In adding up large accounts, some dot at 60 in the pence, and for every dot carry 5 to the shillings; and in adding the shillings they dot likewise at 60, and for every dot carry 3 to the pounds. Others chuse to divide them

them into parcels, then cast up each parcel separately, and afterwards add the sums of the several parcels into one total.

2. AVOIRDUPOIS WEIGHT.

T A B L E.

16 drams	} make {	1 ounce.
16 ounces		1 pound.
28 pounds		1 quarter.
4 quarters		1 hundred.
20 hundreds		1 tun.

Marked thus.

T.	C.	℥.	lb.	oz.	dr.					
1	=	20	=	80	=	2240	=	35840	=	573440
1	=	4	=	112	=	1792	=	28672		

By Avoirdupois weight are weighed butter, cheese, rosin, wax, pitch, tar, tallow, soap, salt, hemp, flax, beef, brass, iron, steel, tin, copper, lead, allum, and all grocery wares.

Note, 19½ C. of lead make a fodder.

In adding the following example, begin with the ounces, and say, 15 and 10 make 25; which being above 16, dot, and carry away the excess 9, saying, 9 of excess and 6 make 15, and 8 make 23; where again dot, and carry away the excess 7, saying, 7 and 2 is 9, and 1 ten on the left is 19; where dot, and proceed with the excess 3, saying, 3 and 4 is 7, and 1 ten on the left is 17; where dot, and carry the excess 1, saying, 1 and 5 is 6, and 1 ten on the left is 16; where again dot, and there being no excess, you have nothing to set down.

(10)	(20)	(4)	(28)	(16)
T.	C.	℥.	lb.	oz.
74	19	3	27	15
85	17	2	24	14
68	13	1	20	12
52	18	3	19	8
50	10	2	18	6
48	9	3	16	10
97	5	1	3	15
<hr/>				
478	15	3	20	

Proceed now to add the pounds; saying 5 carried from the ounces, *vis.* one for every dot, and 3 make 8; and 6 make 14, and 1 ten on the left is 24, and 8 make 32; which being above 28, dot, and go on, saying, 4 of excess and 1 ten on the left is 14, and 9 is 23, and 1 ten on the left is 33; where again dot, and go on, saying, 5 of excess and 20 is 25, and 4 is 29; where dot, and proceed, saying, 1 of excess and 2 tens on the left make 21, and 7 make 28; where dot, and the 2 tens, or 20, on the left, set below.

We should now proceed to add the quarters; saying, 4 carried from the pounds and 1 make 5, &c.; but as you carry here 1 for every four, the quarters are added exactly as the farthings in addition of money. In the hundreds you carry at 20; which, therefore, are added as shillings. The tuns are integers; and added accordingly.

III. Proof of Addition.

ADDITION may be proved several ways.

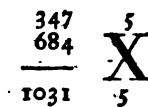
1. Merchants and men of business usually add each column first upwards, and then downwards, and, upon finding the sum to be the same both ways, they conclude the work to be right: and this is all the proof that their time, or the hurry of business, will admit of.

2. It is a common practice in schools, to prove the work by a second summing without the top-line; and if thus sum added to the top-line makes the first total, the work is supposed to be right; as in the following example.

	L.	s.	d.
Top-line	748	15	10½
	674	13	11½
	835	17	9½
	90	18	8
Total	2350	6	3½
Total without the top-line	1601	10	4½
Proof	2350	6	3½

Note, This mark + signifies added to.

3. Addition is also proved by casting out the 9's; for if the excess above the 9's in the total be the same as the excess in the items, the work may be presumed right. Thus, to prove the example in the margin, begin with the items, and say, 3 + 4 = 7, and 7 + 7 = 14 = 1 + 4 = 5; with this 5 pass to the next item, and say, 5 + 6 = 11 = 1 + 1 = 2, and 2 + 8 = 10 = 1, and 1 + 4 = 5; which 5 being the excess of the items, place at the top of the cross, and proceed to cast the 9's out of the total, saying, 1 + 3 = 4, and 4 + 1 = 5; which 5, being the excess of the total, place at the foot of the cross; and because it is the same with the figure at the top, you conclude the work to be right.



If the items are of different denominations; as pounds, shillings, pence, &c.; you must begin with the highest denomination; and, after casting out the 9's, reduce the excess to the next inferior denomination; and then casting out the 9's, reduce the excess to the next inferior denomination; proceed in like manner with this, and all the other lower denominations, placing the last excess at the top of the cross; then, in the same manner, cast the 9's out of the total, placing the excess at the foot of the cross; and if the figure at the foot and top be the same, the work may be presumed right.

If any operation, whether in addition, subtraction, multiplication, or division, be right, this kind of proof will always show it to be so; but if an operation be wrong, by a figure or figures being misplaced, or by miscounting 9, or any just number of 9's, this kind of proof will not discover the mistake.

CHAP. III. SUBTRACTION.

SUBTRACTION is the taking a lesser number from a greater, in order to discover their difference, or the remainder.

I. Subtraction of Integers.

RULE I. Set figures of like place under other, viz. units under units, tens under tens, &c. and the greater of the given numbers uppermost.

II. Beginning at the place of units, take the lower figures from those above, borrowing and paying ten, as need requires, and write the remainders below.

EXAMP. I. Because similar or like things only can be subtracted, place the numbers as directed in Rule I. viz. units under units, tens under tens, &c. and the greatest uppermost, as in the margin.

Then, beginning at the place of units, say, 2 units from 7 units, and 5 units remain; which set below in the place of units; then 6 tens from 6 tens, and nothing remains; wherefore set 0 below, in the place of tens; then 5 hundred from 8 hundred, and 3 hundred remain; which set below, in the place of hundreds; and you will find the total difference or remainder to be 305.

II. Having placed the numbers, units under units, &c. as in the margin, say, 5 units from 2 units, you cannot, but, because an unit in the next superior place makes ten in this place, you must borrow 1, viz. 1 ten, from the said next place, as directed in Rule II.; which 1 ten being added to 2 makes 12; then say, 5 from 12, and 7 remains; which 7 set below in the place of units; then proceed, and pay the unit borrowed, either by esteeming 3, the next figure in the major, to be only 2, or, which is more usual, and the same in effect, by adding 1 to the next figure in the minor, thus, 1 that you borrowed and 8 make 9, from 3 you cannot, but, borrowing as before, you say, 9 from 13 and 4 remains; which 4 set below; proceed, and say, 1 that you borrowed and 7 make 8, from 4 you cannot, but from 14, and 6 remains; which 6 set below: go on, and say, 1 borrowed and 2 make 3, from 7, and 4 remains; which 4 set below. So the difference or remainder is 4647.

II. Subtraction of the parts of Integers; such as Shillings, Pence, Farthings, Ounces, &c.

RULE I. Place like parts under other, viz. farthings under farthings, pence under pence, &c. and the greater of the given numbers uppermost.

II. Begin at the lowest of the parts, and borrow according to the value of an unit of the next superior denomination; viz. in farthings borrow 4, in pence borrow 12, &c. as the tables of money and weights direct.

III. If you borrow 20, 30, 40, 60, or any just number of tens, as in subtracting shillings, degrees, poles, minutes, seconds, &c. proceed with the right-hand column, as in subtraction of integers; and then subtract

your tens, borrowing, if need be, the number of tens contained in an unit of the next superior denomination. The reason appears plain in the following operations.

I. M O N E Y.

Having, according to (10) (20) (12) (4)  
 Rule I. placed like parts L. s. d. f.  
 under other, viz. far- 73 15 10 2 major.  
 things under farthings, 48 12 6 2 minor.  
 pence under pence, &c.  
 and in each of these de- 25 3 4 remainder.  
 nominations, units under

units, tens under tens, and the greater of the given numbers uppermost, as in the margin, begin with the farthings, and say, 2 from 2, and 0 remains; and proceed to the pence, saying, 6 from 10 and 4 remains; which 4 set down, and go on to the shillings, saying 2 from 5 and 3 remains, and 1 from 1, and 0 remains; or you may say at once, 12 from 15, and 3 remains; which 3 being set down, proceed to the pounds, which are integers, and subtracted as such.

In this example say, 3 farthings from 1 farthing you cannot, but as directed in Rule II. you say, 3 from (10) (20) (12)  
 4, the number of farthings L. s. d.  
 in 1 penny borrowed, and 708 14 6½ major.  
 1 remains; which 1 added 170 17 10½ minor.  
 to 1 in the major gives 2  
 farthings for a remain- 429 16 7½ remainder.  
 der; which set down, and

proceed to the pence, saying, 1 penny borrowed and 10 make 11, which from 6 you cannot, but from 12, the number of pence in 1 shilling, and 1 remains; which 1 added to 6 in the major gives a remainder of 7; which set down, and go on to the shillings; and because in subtracting shillings we borrow a just number of tens, viz. 2 tens, or 20, work as directed in Rule III.; and in the right-hand column say, 1 borrowed and 7 make 8, which from 4 you cannot, but from 14, and 6 remains; which being set down, go on to the left-hand column, and say, 1 borrowed and 1 make 2, which from 1 you cannot, but from 2, the number of tens in 1 pound, and nothing remains, which 0 added to 1 in the major gives 1 for a remainder; which set down, and proceed to the pounds, saying, 1 borrowed and 8 make 9, which from 8 you cannot, but from 18, &c.

Note. Some add the number borrowed to the figure or number in the major, and then subtract from their sum. Thus, in the farthings they add the 4 borrowed to 1 in the major, and then from the sum 5 they subtract the 3 in the minor; and in the pence they add the 12 borrowed to 6 in the major, and subtract from the sum 18, &c.; but the method taught above is the easiest and most usual.

2. AVOIRDUPOIS WEIGHT.

BEGIN with the pounds, and (10) (4) (28)  
 say, 24 from 22 you cannot, but £. lb.  
 from 28, the number of pounds in 84 1 22 major.  
 1 quarter, and 4 remains, which 49 3 24 minor.  
 added to 22 in the major, gives 34 1 26 rem.  
 26 for

26 for a remainder; which set below, and proceed to the quarters, saying, 1 quarter borrowed and 3 make 4, which from 1 you cannot, but from 4, the number of quarters in 1 C. and 0 remains, which 0 added to 1 in the major gives 1 for a remainder; which set down, and go on to the C. which are integers, saying, 1 C. borrowed and 9 make 10, which from 4 you cannot, but from 14, &c.

III. *The Proof of Subtraction.*

MERCHANTS and men of business use no other proof besides a reversal of the work, or running over it a second time; but it is usual in schools to put the learner upon proving the operation, by some of the three methods following, viz.

1. The work may be proved by addition; for if you add the remainder to the minor, the sum will be equal to the major, as in the following example.

<i>Examp.</i>	<i>L.</i>	<i>s.</i>	<i>d.</i>
major	73	15	10
minor	48	12	6
	<hr/>		
rem.	25	3	4
	<hr/>		
proof	73	15	10

2. By subtraction; for if you subtract the remainder from the major, the difference will be equal to the minor, as follows.

	<i>L.</i>	<i>s.</i>	<i>d.</i>	
3847	major	73	15	10
2569	minor	48	12	6
	<hr/>			
3278	rem.	25	3	4
	<hr/>			
2569	proof	48	12	6

3. By casting out the 9's; for the major being equal to the sum of the minor and remainder, if you cast the 9's out of the major, and place the excess at the top of the cross, and then cast the 9's out of the minor and remainder, as if they were items in addition, and place the excess at the foot of the cross, it is plain the figure at the top and foot, if the work be right, will be the same. Only, in proving subtraction of money, Avoirdupois weight, &c. care must be taken to begin with the highest denomination, reducing always the excess to the next inferior denomination, as taught in the proof of addition. See the following example.

	<i>L.</i>	<i>s.</i>	<i>d.</i>	
major	73	15	10	X
minor	48	12	6	
	<hr/>			
rem.	25	3	4	

CHAP. IV. MULTIPLICATION.

IN multiplication there are two numbers given, viz. one to be multiplied, called the *multiplicand*; and another that multiplies it, called the *multiplier*; these two go

under the common name of *factors*; and the number arising from the multiplication of the one by the other is called the *product*, and sometimes the *fact*, or the *rectangle*. If a multiplier consists of two or more figures, the numbers arising from the multiplication of these several figures into the multiplicand, are called *particular*, or *partial products*; and their sum is called the *total product*.

Multiplication then is the taking or repeating of the multiplicand, as often as the multiplier contains unity. Or,

Multiplication, from a multiplicand and a multiplier given, finds a third number, called the *product*, which contains the multiplicand as often as the multiplier contains unity.

Hence multiplication supplies the place of many additions; for if the multiplicand be repeated or set down as often as there are units in the multiplier, the sum of these, taken by addition, will be equal to the product by multiplication. Thus,  $5 \times 3 = 15 = 5 + 5 + 5$ .

The first and lowest step in multiplication is, to multiply one digit by another; and the fact or number thence arising is called a *single product*. This elementary step may be learned from the following table, commonly called *Pythagoras's table of multiplication*: which is consulted thus; seek one of the digits or numbers on the head, and the other on the left side, and in the angle of meeting you have their product. The learner, before he proceed further, ought to get the table by heart.

To Pythagoras's table are here added, on account of their usefulness, the products of the numbers 10, 11, 12...

T A B L E.

1	2	3	4	5	6	7	8	9	10	11	12
2	4	6	8	10	12	14	16	18	20	22	24
3	6	9	12	15	18	21	24	27	30	33	36
4	8	12	16	20	24	28	32	36	40	44	48
5	10	15	20	25	30	35	40	45	50	55	60
6	12	18	24	30	36	42	48	54	60	66	72
7	14	21	28	35	42	49	56	63	70	77	84
8	16	24	32	40	48	56	64	72	80	88	96
9	18	27	36	45	54	63	72	81	90	99	108
10	20	30	40	50	60	70	80	90	100	110	120
11	22	33	44	55	66	77	88	99	110	121	132
12	24	36	48	60	72	84	96	108	120	132	144

I. *Multiplication of Integers.*

RULE I. Set the multiplier below the multiplicand, so as like places may stand under other, viz. units under units,

units, tens under tens, &c. : but if either or both of the factors have ciphers on the right hand, set their first significant figures under other.

The order prescribed in this rule is not absolutely necessary, but very convenient as will appear in the examples.

II. Beginning at the right hand, multiply each figure of the multiplier into the whole multiplicand, carrying as in addition, and placing the right-hand figure of each particular product directly under the multiplying figure.

III. Add the particular products, and their sum will be the total product.

EXAMP. I. Having placed the multiplier under the multiplicand, as directed in Rule I. proceed to the operation, and say, 7 times 4 make 28; set the 8 below in the place of units, and carry the 2 tens to the next place, as directed in Rule II. saying 7 times 9 make 63, and 2 that I carried make 65; set 5 below in the place of tens, and the 6, which belongs to the next place, set on its left hand, there being no further place to which it can be carried; so the product is 658.

II. Here first multiply the right-hand figure 8 into the whole multiplicand, as in the former example; then proceed, and multiply likewise the 6 tens into the whole multiplicand, saying 6 times 2 make 12; set the 2 below under the the multiplying figure, viz. in the place of tens, and carry the 1 to the next place, as directed in Rule II. The reason why the 2 is set under the multiplying figure, or in the place of tens, is, because the multiplying figure 6 is really 6 tens or 60, and 60 times 2 make 120; so that by carrying the 1 to the next place, and setting down 20, the 0 would fall into the place of units, and throw the 2 into the place of tens; but as 0 can make no alteration in the addition of the partial products, the setting of it down is safely and justly omitted.

III. When the multiplier has ciphers on the right hand, as it would be evidently lost labour to multiply by the ciphers, their only use being to throw figures on their left hand into higher places, set the first significant figures of the factors under other; and, after the operation is finished, annex the ciphers of the multiplier to the right hand of the product.

IV. When the multiplier has ciphers intermixed with significant figures, omit the ciphers, because the multiplying by them would only produce so many lines of ciphers and so be labour in vain; wherefore multiply by the significant figures only; but take care to place the right-hand figure of each particular product directly under the multiplying figure.

29601847  
 300905  
 148009235  
 266416623  
 88805541  
 8907343771535

*Contractions, and simple ways of working multiplication of integers.*

1. To multiply any number by 10, by 100, by 1000, &c. to the given number annex one, two, three ciphers, &c. Thus,  $23 \times 10 = 230$ ; and  $384 \times 100 = 38400$ ; and  $745 \times 1000 = 745000$ .

2. To multiply any number by 9, by 99, by 999, &c. multiply the given number first by 10, by 100, by 1000, &c. that is, annex one, two, three, &c. ciphers to it; from this subtract the given number, and the remainder is the product; as in the following examples.

Ex. 1.	Ex. 2.	Ex. 3.
Mult. 47	Mult. 627	Mult. 999
by 9 470	by 99 62700	by 999 999000
Sub. 47	Sub. 627	Sub. 999
Prod. 423	Prod. 62073	Prod. 998001

From Ex. 3. we may learn, in general, that to multiply any number consisting entirely of 9's by itself, is to set 1 in the place of units, then as many ciphers, save one, as there are 9's in the given number; then 8, and on the left hand of 8 as many 9's as there are ciphers on its right.

3. To multiply any number by 5; first multiply it by 10, that is, annex a cipher to it, and then halve it: and to multiply any number by 15, use the same method; and add both numbers together, as in the following examples.

Multiply 7439	Multiply 9856
by 5 — 74390	by 15 — 98560 } add
Product 37195	Product 147840

4. To multiply any number by 11, 12, 13, 14, 15, 16, &c. multiply by the unit's figure, and add the back-figure of the multiplicand to the product; and to multiply by 21, 22, 23, 24, 25, 26, 27, &c. add the double of the back-figure; and to multiply by 31, 32, 33, 34, &c. add the triple of it; and to multiply by 112, 113, 114, &c. add the two back-figures; and to multiply by 101, 102, 103, 104, &c. add the next back-figure save one: as in the following examples.

Ex. 1.	Ex. 2.	
876 or multiply by 11	876 or thus, 876	
11 11 thus	876	
9636	9636	
Ex. 3.	Ex. 4.	
435	241	
27	34	
11745	8194	
Ex. 5.	Ex. 6.	Ex. 7.
7234 or thus,	263	745
112	119	103
7234		
810208	31297	76735
	810208	

In multiplying by 12, as in Ex. 8. it is more usual, and equally easy, to proceed by saying, twelve times 8 make 96, and, setting down the 6, say, twelve times 4 is 48, and 9 carried is 57; which set down, and the product is 576.

5. If the multiplier consist of the same figure repeated, as 111, 222, 333, 777, &c. multiply by the unit's figure, and out of that product make up the total product, thus. Begin at the right hand, and first take one figure, then the sum of two, then the sum of three, &c. repeating the operation still from the right hand, as often as there are figures in the multiplier; then neglecting the right-hand figure, or figure in the first place, take the sum of as many figures toward the left hand as the multiplier has places; and if there be not so many, take the sum of all the figures there are; then, neglecting the figures in the first and second place, begin at the figure in the third place, proceed as before; and thus go on till the last or left-hand figure is taken in alone; as in the following examples.

<i>Ex. 1.</i> 7645 33 ----- 22935 pr. by 3.	<i>Ex. 2.</i> 4983 666 ----- 29898 pr. by 6.	<i>Ex. 3.</i> 38 4444 ----- 152 pr. by 4.
---	--	---

252285 total.      3318678 total.      168872 total.

6. The operation may frequently be rendered shorter or easier, either by addition, subtraction, or a more simple multiplication; and the cases of this kind are so numerous and various, that they admit of no limitation. Consult the following examples and directions.

<i>Ex. 1.</i> 488 87 ----- 3066 3504 ----- 38106	<i>Ex. 2.</i> 374 56 ----- 2244 1870 ----- 20944	<i>Ex. 3.</i> 746 84 ----- 2984 5968 ----- 62664
---	---	---

Work the above examples as follows.

*Ex. 1.* Multiply by 7, and add that product to the multiplicand, instead of multiplying by 8.

*Ex. 2.* Multiply by 6, and out of that product subtract the multiplicand, instead of multiplying by 5.

*Ex. 3.* Multiply by 4, and double that product for 8.

H. Multiplication of the parts of Integers.

Here there are three cases.

1. If your multiplier is a single digit, set it under the units figure of the lowest denomination, multiply it into all the parts of the multiplicand, beginning at the lowest, and carrying always as in addition, or according to the value of the next superior place.

*EXAMP.* What is the price of 7 packs of cloth at L. 64, 8 s. 10½ d. per pack?

L. s. d. Here say, 7 times 2 is 14, which is 64 8 10½ 3 pence and 2 farthings over; set down the 2 farthings, and carry 3 to the place of pence, saying, 7 times 10 is 70, and 451 2 1½ 3 that I carried makes 73, which is 6 shillings and 1 penny; set down the

1 penny, and carry 6 to the place of shillings, saying, 7 times 8 is 56, and 6 that I carried is 62, which make 3 pounds and 2 shillings; set down the 2 shillings, and carry 3 to the place of pounds which are integers.

2. If your multiplier consists of two or more figures, multiply continually by its component parts, or by the component parts of the composite number that comes nearest to it, and then multiply the given multiplicand by the difference of the multiplier, and the nearest composite number: the sum or difference of these two products is the answer.

*EXAMP. I.* What is the price of 56 C. tobacco, at L. 2 : 14 : 9½ per C.

Here the component parts are 8 and 7; for 8 × 7 = 56: therefore,

Multiply first by 8, and that product by 7; or, which will give the same answer, multiply first by 7, and then that product by 8.

L. s. d.
2 14 9½
8
-----
21 18 6
7
-----

*EXAMP. II.* What is the price of 126 yards of velvet, at L. 3 : 8 : 4 per yard?

Here multiply first by 6, that product by 7, and that product again by 3: but as the component parts are various, and may be chosen at pleasure, you would have had the same answer, had you multiplied by 9 × 7 × 2; or by 7 × 3 × 3 × 2.

L. s. d.
3 8 4
6
-----
20 10
7
-----
143 10
3
-----
430 10

From the above example may be deduced a general and easy rule for working all questions of this kind; and is of excellent use when the multiplier happens to be a number; viz.

Multiply continually so many times by 10 as there are figures in the multiplier, save one; then multiply the given price by the right-hand figure of the multiplier; and again, the first product of 10 by the following figure of the multiplier; and so on, till you have multiplied by all the figures in the multiplier. The sum of these products is the answer.

*EXAMP. III.* What is the price of 8604 yards of cloth, at 19 s. 6½ d. per yard?

L. s. d. Price of	L. s. d. Price of
19 6½ 1 yd, × 4 =	3 18 2 4 yds.
10	
-----	
9 15 5 10 yds, × 0 =	
10	
-----	
97 14 2 100 yds, × 6 =	586 5 600 yds.
10	
-----	
977 1 8 1000 yds, × 8 =	7816 13 4 8000 yds.

Price of 8604 yards, 8406 16 6

3. If your multiplier consists of integers and parts, the operation is performed by a cross multiplication of the several parts of the multiplier into all the parts of the multiplicand.

The contents of mason and joiners work are frequently cast up by this kind of multiplication; for understanding of which observe, that

The superficial content of any rectangle is found by multiplying the length into the breadth; and the content of a right-angled triangle is found by multiplying the base into half the perpendicular or height.

The dimensions are usually taken in lineal feet, inches, and lines; and the operation is performed by the following rules.

I. Any lineal measure multiplied into the same lineal measure produces squares of that name. Thus, lineal feet multiplied into lineal feet produce square feet; lineal inches into lineal inches produce square inches, &c.

II. Lineal feet into lineal inches produce rectangles 1 foot long and 1 inch broad, which divided by 12 quote square feet; and the remainder multiplied by 12, produces square inches.

III. Lineal feet into lineal lines produce rectangles 1 foot long and 1 line broad, which divided by 144 quote square feet; and the remainders are rectangles equal to square inches.

IV. Lineal inches into lineal lines produce small rectangles 1 inch long and 1 line broad, which divided by 12 quote square inches; and the remainder, multiplied by 12, produces square lines.

EXAMP. I. In an area, pavement, or piece of plaster-work, in length 24 feet 7 inches, and in breadth 18 feet 5 inches, how many square feet?

F.	in.	18×7=126	} by Rule II.
24	7	24×5=120	
18	5	12)246(20	
432	35	24	
20	72	12×6=72	
452	107		

Here multiply 18 lineal feet into 24 lineal feet, and the product is 432 square feet; then multiply 5 lineal inches into 7 lineal inches, and the product is 35 square inches, by Rule I.; then multiply 18 lineal feet into 7 lineal inches, and the product is 126; and again multiply 24 lineal feet into 5 lineal inches, and the product is 120; which added to the former product, gives 246 rectangles, each being 1 foot in length and one inch in breadth; these divided by 12 quote 20 square feet; and the remainder 6 multiplied by 12, produces 72 square inches, according to Rule II.; these add to the former square feet and inches, and you'll find the answer or total product to be 452 square feet, and 107 square inches.

EXAMP. II. In an area or floor, in length 38 feet 9 inches 6 lines, and in breadth 23 feet 8 inches 6 lines, how many square feet?

F.	in.	li.	23×9=207	} By Rule II.
38	9	6	38×8=304	
23	8	6	12)511(42	
874	72	36	48	
4284	278	8	31	
278	8	72	24	
919	98	108	12×7=84	
38×6=228			8×6=48	
23×6=138			9×6=54	
144)366(2			12)102(8	
288			96	
78			12×6=72	

Because the sum of the inches exceeds 144, carry 1 from them to the column of feet, and set down the overplus, viz. 98.

The operation may be rendered easier and shorter by previously reducing the factors to two denominations, viz. inches and lines. Thus the former example may be proposed and wrought as follows.

In an area or floor, in length 465 inches 6 lines, and in breadth 284 inches 6 lines, how many square inches and feet?

Inch.	lin.	465×6=2790	} By Rule IV.
465	6	284×6=1704	
284	6	12)4494(374 in.	
1320	60	12×6=72 li.	
374	72		
132434	108		

The answer here is 132434 square inches, and 108 square lines; and if the inches be divided by 144, you will have 919 square feet and a remainder of 98 square inches, as before.

Or the factors may be reduced to the lowest denomination, viz. lines, and then the product will be square lines, which, divided by 144, will quote square inches, and the remainder will be square lines; and the square inches, divided by 144, will quote square feet, and the remainder will be square inches. Again, the square feet, divided by 9, will quote square yards, and the remainder will be square feet; and the square yards, divided by 36, will quote square rods, and the remainder will be square yards.

If this cross multiplication be extended to the measurement of solids, the content of which is found by multiplying the superficial content of the base into the height, depth, length, or thickness, the operation must be conducted by the following rules.

V. Any superficial measure multiplied into the same lineal measure produces a solid of the same name. Thus superficial feet multiplied into lineal feet produce solid feet; superficial inches multiplied into lineal inches produce solid inches, &c.



VI. Superficial feet into lineal inches produce parallelepipeds, whose base is 1 square foot, and their height 2 inch; which divided by 12 quote solid feet; and the remainder, multiplied by 144, produces solid inches.

VII. Superficial feet into lineal lines produce parallelepipeds, whose base is 1 square foot, and their height 1 line; which divided by 144 quote solid feet; and the remainder multiplied by 12 produces solid inches.

VIII. Superficial inches into lineal lines produce parallelepipeds, whose base is 1 square inch, and their height 1 line; which divided by 12 quote solid inches; and the remainder multiplied by 12 produces solid inches.

IX. Lineal feet into superficial inches produce parallelepipeds, whose base is one square inch, and their height 1 foot; which divided by 144 quote solid feet; and the remainder multiplied by 12 produces solid lines.

X. Lineal feet into superficial lines produce parallelepipeds, whose base is 1 square line, and their height 1 foot; which divided by 12 quote solid inches; and the remainder multiplied by 144 produces solid lines.

XI. Lineal inches into superficial lines produce parallelepipeds, whose base is 1 square line, and their height 1 inch; which divided by 144 quote solid inches; and the remainder multiplied by 12 produces solid lines.

EXAMP. III. In a piece of timber, whose length is 18 feet 16 inches, breadth 2 feet 4 inches, and thickness 2 feet 3 inches, how many solid feet?

F.	in.			
18	6	$2 \times 6 = 12$	} by Rule II.	
2	4	$18 \times 4 = 72$		
36	24	$12)84(7 F.$	} by Rule VI.	
7				
43	24	superficial	} by R. IX.	
2	3	lineal		
86	72		} by R. VIII.	
10	1296			
	576			
97	216	solid		

Here first multiply 18 feet 6 inches into 2 feet 4 inches, as formerly, and the product is 43 feet 24 inches superficial; which next multiply into 2 feet 3 inches lineal, thus, 43 superficial feet into 2 lineal feet produce 86 solid feet, and 24 superficial inches into 3 lineal inches produce 72 solid inches, by Rule V.; then 43 superficial feet into 3 lineal inches produce 129 parallelepipeds, whose base is 1 square foot, and their height 1 inch; which divided by 12 quotes 10 solid feet; and the remainder 9 multiplied into 144 produces 1296 solid inches, by Rule VI. Again, 2 lineal feet into 24 superficial inches produce 48; which, being less than 144, you esteem a remainder, and multiplying it into 12 you have a product of 576 solid inches, by Rule IX.

Because the sum of the inches exceeds 1728, carry r from thence to the feet, and the overplus 216 set down.

EXAMP. IV. How many solid feet in a polished stone, that is 8 feet 9 inches 5 lines long, 7 feet 3 inches broad, and 3 feet 5 lines thick?

F.	in.	l.		
8	9	5	$7 \times 9 = 63$	} by Rule II.
7	3		$8 \times 3 = 24$	
56	27		$12)87(7 F.$	} by Rule III.
7	36		$12 \times 3 = 36 in.$	
	35		$7 \times 5 = 35 in.$	} by Rule IV.
	1	36	$3 \times 5 = 15$	
63	95	36	$12)15(1 in.$	} by R. VII.
3		5	lin.	
189		180	$63 \times 5 = 315, \text{ and } 144)315(2 F.$	} by R. IX.
2	124		$12 \times 27 = 324 in.$	
2108			$3 \times 99 = 297, \text{ and } 144)297(2 F.$	} by Rule X.
	9		$12 \times 9 = 108 in.$	
	41	432	$3 \times 36 = 108, \text{ and } 12)108(9 in.$	} by R. VIII.
193	482	612	$5 \times 99 = 495, \text{ and } 12)495(41 in.$	
			$144 \times 3 = 432 lines.$	

The operation may be facilitated by previously reducing the three factors to two denominations, viz. inches and lines, as was done in Example II. on superficial measure.

Or the three factors may be reduced to the lowest denomination, viz. lines, which being multiplied continually, will produce solid lines, which divided by 1728, will quote solid inches, the remainder being solid lines; and the solid inches divided by 1728 will quote solid feet, the remainder being solid inches; and the solid feet divided by 27 will quote solid yards, the remainder being solid feet; and the solid yards divided by 216 will quote solid rods, the remainder being solid yards.

We shall only further observe, that as the rules for working questions by cross multiplication are numerous, and the operation tedious, it is easier to convert the parts into a decimal fraction of their integer, and then work as taught in the multiplication of decimals.

III. The Proof of Multiplication:

MULTIPLICATION may be proved several ways, viz. by multiplication, by division, and by casting out the 9's.

1. By multiplication: Change the places of the factors, and make that the multiplier which before was the multiplicand; and if the work be right, you will have the same product as before; but this method is tedious.

2. By division: When the work is right, the product divided by the multiplier quotes the multiplicand; or, divided by the multiplicand, quotes the multiplier. But this supposes the learner acquainted with division.

3. The most usual method therefore of proving multiplication is by casting out the 9's; which is done thus: Cast the 9's out of the multiplicand and multiplier, and place the excesses on the right and left sides of a cross; multiply these two figures into one another, casting the 9's out of their product, if need be, and place the excess at the top of the cross; then casting the 9's also out of the product of your multiplication, place its excess at the bottom;

bottom; and if the work be right, the figures at top and bottom will agree, or be the same.

$$\begin{array}{r}
 754 \\
 38 \\
 \hline
 6032 \\
 2262 \\
 \hline
 28652
 \end{array}
 \quad
 \begin{array}{c}
 5 \\
 2 \times 7 \\
 5
 \end{array}$$

EXAMP. I. Here cast the 9's out of the multiplicand, and place the excess 7 on the right side of the cross; then cast the 9's out of the multiplier, and place the excess 2 on the left side of the cross; next multiply these excesses 2 and 7 into one another, cast the 9's out of their product, and place the excess five at the top of the cross; lastly, cast the 9's out of the product, and place the excess 5 at the foot of the cross; which being the same with the figure at the top, you may conclude the work to be right.

$$\begin{array}{r}
 L. \quad s. \quad d. \\
 43 \quad 8 \quad 4\frac{1}{2} \\
 \hline
 347 \quad 6 \quad 10
 \end{array}
 \quad
 \begin{array}{c}
 7 \\
 8 \times 2 \\
 7
 \end{array}$$

EXAMP. II. Here, in casting the 9's out of the multiplicand, and out of the product, begin with the pounds, and reduce the excess to shillings, and in like manner the excess of the shillings is reduced to pence, and that of the pence to farthings. The multiplier being an abstract number, needs no reduction; but if a multiplier be a mixt number, or consist of integers and parts, as feet and inches, &c. the excess of the higher denomination must always be reduced to the lower.

CHAP. V. DIVISION.

DIVISION discovers how often one number is contained in another: or,

Division, from two numbers given, finds a third, which contains unity as often as the one given number contains the other.

The number to be divided, or which contains the other, is called the *dividend*; the number by which we divide, or which is contained in the dividend, is called the *divisor*; and the number found by division, or which expresses how often the dividend contains the divisor, is called the *quotient* or *quot.*

As multiplication supplies the place of many additions, so division, which is the reverse of multiplication, serves instead of many subtractions; as will thus appear: Suppose it were required to divide 18 by 6, that is, to find how often 6 is contained in 18, the work by subtraction will stand as in the margin: by which it appears, that 6 is contained 3 times in the number 18. But this, by division, may be found at one trial: thus,

Set the divisor on the left of the dividend, leaving room on the right hand for the quotient, as in the margin; and then say, How often 6 in 18? *Ans.* 3 times: this 3 set in the quotient; then multiply the quotient figure 3 into the divisor 6, saying, 3 times 6 make 18; which set down below the dividend, and subtract it from the dividend, and 0 remains.

$$\begin{array}{r}
 18 \\
 6 \\
 \hline
 12 \\
 6 \\
 \hline
 6 \\
 6 \\
 \hline
 0
 \end{array}$$

I. Division of Integers.

RULE I. From the left-hand part of the dividend point off the first *dividual*, viz. so many figures as will contain the divisor.

II. Ask how often the divisor is contained in the *dividual*, and put the answer in the quotient.

III. Multiply the divisor by the figure set in the quotient, and subtract the product from the *dividual*.

IV. To the right of the remainder bring down the next figure of the dividend for a new *dividual*; and then proceed as before.

EXAMP. I. Here, because the divisor 7 is contained in 8, the left-hand figure of the dividend, point it off as the first *dividual*, according to Rule I; and then say, How often 7 in 8? *Ans.* 1 time; which 1 set in the quotient, as directed in Rule II.; then multiply the divisor 7 by this quotient figure 1, and subtract the product 7 from the *dividual* 8, as directed in Rule III.; to the remainder 1 bring down the following figure of the dividend, for the second *dividual*, as directed in Rule IV.; then proceed as before, and say, How often 7 in 17? *Ans.* 2 times; wherefore, setting two in the quotient, multiply and subtract and find the next remainder to be 3; to which bring down the following figure of the dividend, and you have 35 for the third *dividual*; then say, How often 7 in 35? *Ans.* 5 times; which 5 being placed in the quotient, multiply and subtract, and 0 remains; so the quotient is 125.

Divi-	Divi-	Quo-
for.	dend.	tient.
	7)875(125	
	...	
	7	—
	17	—
	14	—
	35	—
	35	—
	(0)	

By reviewing the steps of the preceding operation, and reducing the *dividuals* and quotient-figures to their separate values, the reason of the rules will be obvious; for,

The separate value of the first *dividual* 8 is 800; and the separate value of 1, the first figure put in the quot, is 100; for as 8 contains 7 the divisor 1 time, so 800 contains it 100 times, and 100 remains; to which bring down the following figure of the dividend 7, whose separate value is 70; and the second *dividual* is 170; and as 7 is contained 2 times in 17, so it is contained 20 times

	7)875(100)	} partial quot.
1st	dividual 800	
	700	
	—	
rem.	100	125 total quot.
	add 70	
	—	
2d	dividual 170	
	140	
	—	
rem.	30	
	add .5	
	—	
3d	dividual 35	
	35	
	—	
	(0)	

in 170, and 30 remains; to which bring down the next or last figure of the dividend 5; and the third *dividual* is

is 35, in which the divisor 7 is contained 5 times. Now it is evident, that the sum of the partial quots, 125, is the total quot, or a number expressing how often the dividend 875 contains the divisor 7.

From the above example we may learn, that there are always just so many figures in the quotient as there are dividuuls; or the first dividuul, with the number of subsequent figures in the dividend, is equal to the number of places or figures in the quotient.

Hence likewise may be inferred, that no divisor is contained in any dividuul oftener than 9 times; for the dividuul, excluding the right-hand figure, is always less than the divisor by 1 at least; and if both be multiplied by 10, or have a cipher annexed to each of them, the product of the dividuul will be less than the product of the divisor by 10 at least; but no right-hand figure can supply this defect of 10; therefore the divisor is not contained 10 times in any dividuul, and consequently not oftener than 9 times.

Here too observe, that the right-hand figure of the first dividuul, and all the subsequent figures of the dividend, have a point or dot set below them, as they are brought down; which is done to prevent mistakes, by distinguishing them, in this manner, from the figures not yet brought down.

8)56032897 (7004112 <sup>1</sup> numer. / <sub>8</sub> denom.

56  
 032  
 32  
 8  
 8  
 9  
 8  
 17  
 16  
 (1)

EXAMP. II. Here, because 8 is not contained in 5, point off 56 as the first dividuul, and say, How often 8 in 56? *Ans.* 7; which put in the quotient; then multiply 7 into the divisor 8, and subtract the product 56 from the dividuul; and as nothing remains, bring down the next figure of the dividend, which happens to be a cipher; and as you cannot have 8 in 0, put 0 in the quotient;

and, as multiplying and subtracting is in this case needless, you bring down the next figure of the dividend 3; and as you cannot have 8 in 3, put another 0 in the quotient, and bring down the next figure of the dividend 2: Then say, How often 8 in 32? *Ans.* 4; which put in the quotient: Then multiply and subtract; and as nothing remains, bring down the next figure of the dividend 8, and say, How often 8 in 8? *Ans.* 1; which put in the quotient: then multiply and subtract; and as nothing remains, bring down the next figure of the dividend 9, and say, How often 8 in 9? *Ans.* 1; which put in the quotient: then multiply and subtract; and to the remainder 1 bring down the next and last figure of the dividend 7, and say, How often 8 in 17? *Ans.* 2; which put in the quotient: then multiply and subtract, and 1 remains.

To complete the quotient, draw a line on the right hand, and set the remainder above the line, and the di-

visor 8 below it, signifying that 1 remains to be divided by 8; or this part of the quotient may be considered as a fraction, whose numerator is 1, and its denominator 8; and the quotient thus completed shews, that the dividend contains the divisor 7004112 times, and one eighth part of a time.

Here observe, that not only the last remainder, but every other remainder, must be less than the divisor; for if it be either greater or equal, the divisor might have been oftener got, and the quotient-figure is too little. And should any one in this case attempt to continue the operation, the quotient-figures would be all 9's, the dividuuls would prove inexhaustible, and the remainders would constantly increase.

Hence also learn, that if any dividuul happen to be less than the divisor, you must put 0 in the quotient, and bring down the next figure of the dividend; and if it be still less than the divisor, you must put another 0 in the quotient, and bring down the following figure of the dividend, &c.

III. Here the divisor consists of two figures; and because it is contained in the two left-hand figures of the dividend 78, point them off as the first dividuul; and say, How often 3 in 7? *Ans.* 2, and 1 remains; which 1 placed, or conceived as placed, on the left hand of the following figure 8, makes 18: then say, Can I have the following figure of the divisor 6 also 2 times in 18? *Ans.* Yes; consequently I get 36 the divisor 2 times in 78 the dividuul; wherefore put 2 in the quotient, and multiply that 2 into the divisor 36, and subtract the product 72 from the dividuul 78; and to the remainder 6 bring down the following figure of the dividend 9, for a new dividuul: then say, How often 3 in 6? *Ans.* 2, and 0 remains; again you say, Can I have 6 also 2 times in 9? *Ans.* No; therefore you can have 36 in 69 only 1 time, which 1 you put in the quotient: then multiply and subtract as before; and to the remainder 33 bring down the next figure 4 for a new dividuul: Then, because the dividuul consists of a figure more than the divisor, say, How often the first figure of the divisor 3 in the first two figures of the dividuul 33? *Ans.* 9, and 6 remains; which 6 placed on the left hand of the following figure 4 makes 64: Again, say, Can I have 6 also 9 times in 64? *Ans.* Yes; consequently 36 can be had 9 times in 334; wherefore you put 9 in the quotient: Then multiply and subtract; and to the remainder 10 bring down the next figure 2 for a new dividuul: Here likewise, because the dividuul has a figure more than the divisor, say, How often 3 in 10? *Ans.* 3, and 1 remains; which 1 placed on the left hand of the following figure 2 makes 12: Again say, Can I have 6 also 3 times in 12? *Ans.* No; consequently 36 cannot be had 3 times in 102; wherefore try if

36)789426(21928 <sup>1</sup>/<sub>8</sub>  
 .....  
 72  
 69  
 36  
 334  
 324  
 102  
 72  
 306  
 288  
 (18)

you can have it 2 times; saying, 2 times 3 is 6 from 10, and 4 remains; which 4 placed on the left hand of the next figure 2 makes 42: And again say, Can I have 6 also 2 times in 42? *Ans.* Yes; consequently 36 can be had 2 times in 102; accordingly put 2 in the quotient, multiply and subtract; and to the remainder 30 bring down the next and last figure of the dividend 6, for a new dividend: Then, because the dividend has a figure more than the divisor, say, How often 3 in 30? *Ans.* 9, and 3 remains; which 3 placed on the left hand of the following figure 6 make 36: And again say, Can I have 6 also 9 times in 36? *Ans.* No; consequently 36 cannot be had 9 times in 306; therefore try if it can be had 8 times, saying, 8 times 3 is 24 from 30, and 6 remains; which 6 placed on the left hand of the following figure 6 makes 66: Again say, Can I have 6 also 8 times in 66? *Ans.* Yes; consequently 36 can be had 8 times in 306; wherefore put 8 in the quotient, and multiply and subtract as before: The last remainder 18 is the numerator of a fraction, and the divisor its denominator, to be annexed to the integral part of the quotient; as was taught in the former example.

The preceding operation points out the manner of procedure when the divisor consists of more figures than one, *viz.* you must take the first figure of the divisor out of the first figure of the dividend, or out of the first two figures of the dividend in case the dividend have a figure more than the divisor: Then imagine the remainder to be prefixed to the next figure of the dividend, and try if you can have the second figure of the divisor as often out of this number; if you can, imagine again the remainder to be prefixed to the following figure of the dividend, and try if you can have the third figure of the divisor as often out of this number, &c.; but if you find you cannot have some subsequent figure of the divisor so often as you took the first, you must go back, and take the first figure of the divisor 1 time less, or some number of times less out of the first, or out of the first two figures of the dividend: Then proceed as before, repeating the trial till you find you have the second and all the subsequent figures of the divisor as often as you took the first.

But here observe, that if, in trying how often the divisor can be had in the dividend, either 9, or a number greater than 9, any where remain, you may conclude, without further trial, that all the subsequent figures of the divisor can be had as often as you took the first; as may be thus demonstrated.

Suppose the subsequent figures of the divisor to be the highest possible, that is, all 9's, and the following figures of the dividend the lowest possible, that is, all 0's; again, imagine the remainder 9 prefixed to the following figure of the dividend 0, that it will make 90; now it is plain, that the subsequent figure of the divisor 9 can be had in 90, the highest number of times possible, *viz.* 9 times, and 9 will remain; which prefixed to the next figure of the dividend 0, makes 90, in which the subsequent figure of the divisor 9 can again be had 9 times, and 9 will remain as before; therefore all the subsequent figures of the divisor can be had as often as you took the first; and if they can be had in this case, much more can they be had when a number greater than 9 remains.

IV. If, as in the margin, a cipher or ciphers, possess the right hand of the divisor, cut them off, and cut off as many figures, *viz.* in this example, the figure 2 from the right hand of the dividend; then divide the remaining figures of the dividend, *viz.* 89678, by the remaining figures of the divisor, *viz.* 648, and you have the integral part of the quotient; but to the remainder 254 annex the figure cut off from the dividend, and you have 2542 for the numerator of your fraction, and the whole divisor 6480 is the denominator.

$$\begin{array}{r}
 648 \overline{) 896782} \left( 138 \frac{254}{648} \right. \\
 \underline{648} \phantom{0} \\
 2487 \phantom{0} \\
 \underline{1944} \phantom{0} \\
 5438 \phantom{0} \\
 \underline{5184} \phantom{0} \\
 (2542)
 \end{array}$$

The reason will appear obvious by working a question in this manner, and also at full length, without cutting off the cipher or ciphers, and then comparing the two operations.

V. If, as in the margin, the last remainder, without regarding the ciphers cut off, is the numerator of your fraction, and the significant figures of the divisor the denominator. The reason is assigned in the doctrine of fractions.

$$\begin{array}{r}
 48 \overline{) 978000} \left( 20375 \right. \\
 \underline{96} \phantom{000} \\
 180 \phantom{00} \\
 \underline{144} \phantom{00} \\
 (36)
 \end{array}$$

In like manner, if there be cut off from the dividend any number of significant figures, with a cipher or ciphers on their right hand; in this case the last remainder, with the significant figures cut off, make the numerator of your fraction; and the significant figures of the divisor, with as many ciphers as the number of significant figures cut off from the dividend, make the denominator. Thus, if, in the above example, the figures cut off from the dividend had been 50, the numerator of your fraction would have been 365, and the denominator 480.

*Contractions in working Division of Integers.*

1. To divide any number by 10, 100, 1000, &c. you have only to point off for a remainder as many figures on the right hand of the dividend as the divisor has ciphers, and the other figures on the left of the point or separatrix are the quotient. Thus, 7489634 divided by 10, 100, 1000, &c. stands as follows.

$$\begin{array}{r}
 \text{Quot. rem.} \\
 10)748963.4 \\
 100)74896.34 \\
 1000)7489.634 \\
 10000)748.9634
 \end{array}$$

2. If the figures of the divisor are all 9's, or all except the units figure, as 9, 99, 999, 98, 997, 9996, &c. work as follows:

Find a new divisor, by annexing to unity as many ciphers as there are figures in the given divisor, subtract the given from the new divisor, and the remainder or difference is the complement. Divide the given dividend by the new divisor, *viz.* point off so many figures on the

the right hand as there are ciphers in the said divisor; the figures thus pointed off are to be esteemed a remainder, and the other figures on the left hand are to be accounted a quotient; then multiply this quotient by the complement, placing the units of the product under the units of the former remainder; again, divide this product by the new divisor, by pointing off from the right hand the same number of figures as in the former remainder, and the figures to the left are to be esteemed another quotient; which quotient you are again to multiply by the complement, and divide as before. And in this manner proceed till the last quotient is nothing; then add as in addition of integers, observing the carriage from the left hand column of the remainders; to the remainders add the product of the said carriage and complement, and the sum is the total remainder; and the sum of the several quotients is the total quotient required.

**EXAMPLE.**

Divide 74678 by 98.  
 New divisor 100          100)746.98  
 Given divisor 98            14.92=746X2  
   .28=14X2  
 Complement 2              \_\_\_\_\_  
 Tot. quot. 762.18+4=22 total rem.  
 Carriage 2X2 complement=4

**EXPLICATION.**

First, to unity annex two ciphers, because the given divisor consists of two figures, and so the new divisor is 100; from which subtract the given divisor 98, and there remains 2 for the complement.

Next divide the given dividend by the new divisor, viz. point off 98, the two figures next the right hand, for the first remainder; and the figures on the left, namely, 746, is the quotient.

Then multiply the said first quotient 746 by the complement 2; and by the new divisor divide the product 1492, viz. point off 92 for the second remainder, and 14 is the second quotient.

Again, multiply the second quotient 14 by the complement 2, and the product 28, divided by 100, gives 28 for the third remainder, but nothing to the quotient.

Then add the several remainders and quotients, and find the total quotient amounts to 762, and the remainders to 18.

Lastly, multiply 2, the carriage from the left-hand column of the remainders, by the complement 2; and the product 4 add to the remainders 18, and the sum 22 is the total remainder.

**II. Division of the parts of Integers.**

HERE there are three cases:

1. If the divisor be a digit, by it divide the integers of the dividend, reduce the remainder to the parts of the next inferior denomination, and add it, when thus reduced, to the said parts; then divide the sum, reducing and adding the remainder to the parts of the following denomination, &c.
- Note.* If the integral part of the dividend be less than the divisor, you must, in the first place, reduce it to the parts of the next denomination.

EXAMP. I. If L. 274 : 13 : 8 : 3 be equally divided: among 8 men, what will each man's share be?

Here first divide the integers L. 274 by 8, and the quotient is L. 34, and L. 2 remains; which reduced to the next denomination makes 40 shillings; and these added to 13 shillings make 53 shillings; which divided by 8 gives 6 shillings to the quotient, and 5 shillings remains; which 5 shillings reduced make 60d. and 60d. added to 8d. make 68d.; which divided by 8 gives 8d. to the quotient, and 4d. remains, &c.

The operation may, if you please, be drawn out at large; as in the following

<p>8)274   13 8 3 dividend.            34    6 8 2 ¼ quotient.</p>	<p>L.   s.   d.   f.          8)274   13 8 3 dividend.            34    6 8 2 ¼ quotient.</p>
--	---

<p>Here divide the C. 43 by 5, and the quotient is C. 8, and C. 3 remains; which reduced, and added to the 2 Q. makes 14 Q. which divide by 5, &amp;c.</p>	<p>C.   ʒ.   lb.   C.   ʒ.   lb.          5)43   2 8 ( 8 2 24            40            —             3 rem.             4             —            14            10            —             4 rem.             28            —           120            10            —            20            20            —             0</p>
--	---

2. If the divisor consists of two or more figures, and be a composite number, resolve it into its component parts, and divide the given dividend by one of these parts, the quotient by another, &c. and the last quotient is the answer.
3. If the divisor consists of integers and parts, reduce both divisor and dividend to the same denomination, and then proceed as in division of integers.

**III. The Proof of Division.**

DIVISION may be proved several ways, viz. by multiplication, by division, and by casting out the 9's.

1. By multiplication: Multiply the quotient by the divisor, or the divisor by the quotient; and the product with the remainder added to it, will be equal to the dividend: Or, take the products of the quotient-figures into the divisor, add them in the order they stand under the dividuale; and their sum, with the remainder, will be equal to the dividend.
2. By division: Divide the difference of the dividend and remainder by the quotient, and your next quotient will be equal to your first divisor, without any remainder. But this method is tedious.
3. By casting out the 9's: Cast the 9's out of the divisor

visor and quotient, place the excesses on the right and left sides of a cross; then multiply these two figures into one another, and cast the 9's out of their product; add the excess to the remainder; and, casting out the 9's if need be, place the sum or excess at the top of the cross; then cast the 9's out of the dividend, and set the excess at the bottom. If the work be right, the figures at the top and bottom of the cross will agree, or be the same.

These methods of proof are a proper exercise to the learner in schools; but, in business, the only proof used is a careful revival of the operation.

CHAP. VI. REDUCTION.

REDUCTION teacheth how to bring a number of one name or denomination to another of the same value; and is either descending, ascending, or mixt.

I. Reduction descending brings a number of a higher denomination to a lower, when the lower is some aliquot part of the higher; as pounds to shillings, pence, or farthings; and is performed by multiplication.

II. Reduction ascending brings a number of a lower denomination to a higher, when the lower is some aliquot part of the higher; as shillings, pence, or farthings, to pounds; and is performed by division.

III. Mixt reduction brings a number of one denomination to another, when the one is no aliquot part of the other; as pounds to guineas, and requires the use of both multiplication and division.

In treating of reduction we shall conjoin the descending and ascending, the one serving as a proof of the other; and shall afterwards treat of mixt reduction by itself.

In working reduction, of whatever kind, the following rule is to be observed, viz.

Multiply or divide as the tables of money and weights direct.

Reduction descending and ascending.

I. M O N E Y.

QUEST. I. In L. 472 how many shillings, pence, and farthings?

This reduction is descending, therefore multiply the pounds by 20, because 20 shillings make 1 pound, and the product is shillings: then multiply the shillings by 12, because 12 pence make 1 shilling, and the product is pence: lastly, multiply the pence by 4, because 4 farthings make 1 penny, and the product is farthings.

472	pounds.
20	
9440	shillings.
12	
1888	
4	
944	
113280	pence.
4	
453120	farthings.

Proof by Reduction ascending.

In 453120 farthings how many pence, shillings, and pounds?

Here divide the farthings by 4, because 4 farthings make 1 penny, and the quotient is pence: then divide the pence by 12, because 12 pence make 1 shilling, and the quotient is shillings: lastly, divide the shillings by 20, because 20 shillings make 1 pound, and the quotient is pounds.

4)453120	farthings.
12)113280	pence.
20)9440	shillings.
472	pounds.

Note 1. To reduce pounds to pence at one operation, multiply by 240, the number of pence in 1 pound.

Note 2. To reduce pounds to farthings at one operation, multiply by 960, the number of farthings in 1 pound.

Note 3. To reduce shillings to farthings at one operation, multiply by 48, the number of farthings in 1 shilling.

Note 4. To reduce pence to pounds at one operation, divide by 240, the pence in 1 pound.

Note 5. To reduce farthings to pounds at one operation, divide by 960, the farthings in 1 pound.

Note 6. To reduce farthings to shillings at one operation, divide by 48, the farthings in 1 shilling.

Here follows the farthings of Quest. 1. reduced back to pounds by these notes.

By note 4.  
 4)453120 farthings.  
 24|0)113280|0 d. (472 L.  
 96  
 172  
 168  
 48  
 48  
 0

By note 5.  
 960)453120(472 L.  
 384  
 691  
 672  
 192  
 192  
 0

By note 6.  
 48)453120(9440 shillings.  
 432 472 pounds.  
 311  
 192  
 192  
 192  
 0

2. AVOIR-

2. AVOIRDUPOIS WEIGHT.

Quest. 1. In C. 47 : 1 : 20 how many ounces?

C.	Q.	lb.
47	1	20
4		
—		
189	Q.	
28		
—		
1512		
380		
—		
5312		lb.
16		
—		
31872		
5312		
—		
84992		oz.

P R O O F.

In 84992 ounces how many lb. Q. and C.

28)	4)	C.	Q.	lb.
16(84992,	5312	(189	(47	1 20
80	28	16		
—				
49	251	29		
48	224	28		
—				
19	272	(0) Q.		
16	252			
—				
32	(20) lb.			
32				
—				
(0)				

Mixt Reduction.

In working mixt reduction observe the following  
**RULE.** By reduction descending bring the given name to some such third name as is an aliquot part both of the name given and of the name sought, and then by reduction ascending bring the third name to the name sought.

Mixt reduction, as well as reduction descending and ascending, extends to money, as follows.

Quest. In 764l. how many guineas?

Here the given name is pounds, the name sought is guineas, and the third name, to which the pounds are reduced, is shillings; for a shilling is an aliquot part both of a pound and of a guinea.

764 pounds.	
20	
—	
21)15280(727 guineas.	
147	
—	
58	
42	
—	
160	
147	
—	
(13) Shillings.	

P R O O F.

In 727 guineas 13 shillings, how many pounds?

Guineas.	shill.
727	13
21	
—	
730	
1455	
—	
210)15280	
—	
764	pounds.

CHAP. VII. THE RULE OF THREE.

THE Rule of Three, called also, on account of its excellence, the *Golden Rule*, from certain numbers given finds another; and is divided into simple and compound, or into single and double.

SECT. I. The Simple or Single Rule of Three.

THE simple rule of three, from three numbers given, finds a fourth, to which the third bears the same proportion as the first does to the second.

The nature and properties of proportional numbers may be understood sufficiently for our purpose from the following observations.

In comparing any two numbers, with respect to the proportion which the one bears to the other, the first number, or that which bears proportion, is called the *antecedent*; and the other, to which it bears proportion, is called the *consequent*; and the quantity of the proportion or ratio is estimated from the quot arising from dividing the antecedent by the consequent. Thus the ratio or proportion betwixt 6 and 3 is the quot arising from dividing the antecedent 6 by the consequent 3; namely, 2; and the ratio or proportion betwixt 1 and 2 is the quot arising from the division of the antecedent 1 by the consequent 2; namely  $\frac{1}{2}$ , or one half.

Four numbers are said to be proportional when the ratio of the first to the second is the same as that of the third to the fourth; and the proportional numbers are usually distinguished from one another as in the following examples.

$$4 : 2 :: 16 : 8 \qquad 6 : 9 :: 12 : 18.$$

Proportional numbers, or numbers in proportion, are usually denominated *terms*; of which the first and last are called *extremes*, and the intermediate ones get the name of *means*, or *middle terms*.

If four numbers are proportional, they will also be inverfely proportional; that is, the first consequent will be to its own antecedent as the second consequent is to its antecedent; or the fourth term will be to the third as the second is to the first. Thus, if  $6 : 2 :: 10 : 5$ , then by inversion,  $3 : 6 :: 5 : 10$ , or  $5 : 10 :: 3 : 6$ . *Euclid* v. 4. cor. By either of these kinds of inversion may any question in the rule of three be proved.

If four numbers are proportional, they will also be alternately proportional; that is, the first antecedent will be to the second as the third consequent is to the fourth.

be to the second antecedent as the first consequent is to the second consequent; or the first term will be to the third term as the second term is to the fourth. Thus, if  $8 : 4 :: 24 : 12$ , then, by alternation,  $8 : 24 :: 4 : 12$ . *Euclid v. 16.*

But the celebrated property of four proportional numbers is, that the product of the extremes is equal to the product of the means. Thus, if  $2 : 3 :: 6 : 9$ , then  $2 \times 9 = 3 \times 6 = 18$ . *Euclid vi. 16.*

Hence we have an easy method of finding a fourth proportional to three numbers given, *viz.*

Multiply the middle number by the last, and divide the product by the first, the quot gives the fourth proportional.

**EXAMP.** Given 6, 5, and 36, to find a fourth proportional; put  $x$  equal to the fourth proportional, then  $6 : 5 :: 36 : x$ , and  $5 \times 36 = 180 = 6 \times x$ ; wherefore, dividing the product 180 by the factor 6, the quot gives the other factor  $x$ , namely 30, the fourth proportional sought.

Every question in the rule of three may be divided into two parts, *viz.* a supposition and a demand; and of the three given numbers, two are always found in the supposition, and only one in the demand.

**EXAMP.** If 4 yards cost 12 shillings, what will 6 yards cost at that rate?

In this question the supposition is, If 4 yards cost 12 shillings; and the two terms contained in it are 4 yards and 12 shillings: The demand lies in these words, What will 6 yards cost? and the only term found in it is 6 yards.

The supposition and demand being thus distinguished, proceed to state the question, or to put the terms in due order for operation, as the following rules direct.

**RULE I.** Place that term of the supposition, which is of the same kind with the number sought, in the middle. The two remaining terms are extremes, and always of the same kind.

II. Consider, from the nature of the question, whether the answer must be greater or less than the middle term; and if the answer must be greater, the least extreme is the divisor; but if the answer must be less than the middle term, the greatest extreme is the divisor.

III. Place the divisor on the left hand, and the other extreme on the right; then multiply the second and third terms, and divide their product by the first; and the quot gives the answer; which is always of the same name with the middle term.

When the divisor happens to be the extreme found in the supposition, the proportion is called *direct*; but when the divisor happens to be the extreme in the demand, the proportion is *inverse*.

The three rules delivered above are indeed so framed, as to preclude the distinction of direct and inverse, or render it needless, the left-hand term being always the divisor; but yet the direct questions being plainer in their own nature, and more easily comprehended by a learner, we shall, in the first place, exemplify the rules by a set of questions of the direct kind, and shall afterwards adduce an example or two of such as are inverse.

I. The Simple Rule of Three Direct.

**QUEST. 1.** If 4 yards cost 12 shillings, what will 6 yards cost at that rate?

The supposition and demand of this question have already been distinguished, and the two terms in the former are 4 yards 12 shillings, and the only term in the latter is 6 yards.

The number sought is the price of six yards, and the term in the supposition of the same kind is the price of 4 yards, *viz.* 12 shillings, which place in the middle, as directed in Rule I. and the two remaining terms are extremes, and of the same kind, *viz.* both lengths.

It is easy to perceive that the answer must be greater than the middle term; for 6 yards will cost more than 4 yards; therefore the least extreme, *viz.* 4 yards, is the divisor, according to Rule II.

$$\begin{array}{r}
 \text{Yds. s. yds.} \\
 \text{If } 4 : 12 :: 6 \\
 \quad 6 \\
 \hline
 4 \overline{) 72} \text{ (18 shillings } \textit{Ans.} \\
 \quad 4 \\
 \hline
 \quad 32 \\
 \quad 32 \\
 \hline
 \quad (0)
 \end{array}$$

Wherefore place the divisor 4 yards on the left hand, and the other extreme 6 yards on the right; and multiplying the second and third terms, divide their product by the first term, and the quot 18 is the answer, and of the same name with the middle term, *viz.* shillings, according to Rule III.

And because the divisor is the extreme found in the supposition, the proportion is direct.

**QUEST. 2.** If 7 C. of pepper cost 21 l. how much will 5 C. cost at that rate?

The supposition in this question is, that 7 C. of pepper costs 21 l. and the two terms in it are 7 C. and 21 l.; the demand is, How much will 5 C. cost? and the term in it is 5 C.

The number sought is the price of 5 C. and the term in the supposition of the same kind is the price of 7 C. *viz.* 21 l. which place in the middle. The two remaining terms are extremes, and of the same kind, *viz.* quantities of pepper.

It is obvious, that the answer must be less than the middle term; for 5 C. will cost less than 7 C.; and therefore the greatest extreme, *viz.* 7 C. is the divisor.

$$\begin{array}{r}
 \text{C. L. C.} \\
 \text{If } 7 : 21 :: 5 \\
 \quad 5 \\
 \hline
 7 \overline{) 105} \text{ (15 l. } \textit{Ans.} \\
 \quad 7 \\
 \hline
 \quad 35 \\
 \quad 35 \\
 \hline
 \quad (0)
 \end{array}$$

Accordingly place the divisor 7 C. on the left hand, and the other extreme 5 C. on the right; and having multiplied the second and third terms, divide their product



by the first term, and the quot 15 is the answer, of the same name with the middle term, viz. L. Sterling.

And because the divisor happens to be the extreme in the supposition, the proportion is direct.

QUEST. 3. If 13 yards of velvet cost L. 21, what will 27 yards cost at that rate?

T. L. T.  
 If 13 : 21 :: 27 \* Rem. 4 s.  
 27                      12  
 ---  
 147                    13)48(3 d.  
 42                      39  
 ---  
 13)567(43 L.      Rem. 9 d.  
 52                      4  
 ---  
 47                    13)36(2 f.  
 39                      26  
 ---  
 Rem. 8 L.            Rem. 10 f.  
 20  
 ---  
 13)160(12 s.  
 13  
 ---  
 30      L. s. d. f.  
 26      Ans. 43. 12 3 2 1/11

\* Rem. 4 s.  
 Such remainders are always of the same name with the preceding part of the quot. Thus, the first remainder 8, and the first part of the quot 43, are both pounds; and the second remainder 4, and the second part of the quot 12, are both shillings; and the third remainder 9, and the third part of the quot 3, are both pence; and the fourth remainder 10, and the fourth part of the quot 2, are both farthings.

As we have no money under farthings, the last remainder cannot be reduced any lower; so there remains 10 farthings to be divided by 13; that is, there is wanting to complete the quot, the thirteenth part of 10 farthings, or the thirteenth part of every remaining farthing; that is, ten thirteenth parts of one farthing; so you set the remainder 10 above, and the divisor 13 below a line drawn between them, in the form of a fraction, of which the remainder is the numerator, and the divisor the denominator.

II. The Simple Rule of Three Inverse.

QUEST. 1. If 8 men can do a piece of work in 12 days, in how many days will 16 men do the same?

In this question the supposition is, If 8 men do a piece of work in 12 days, and the two terms contained in it are 8 men and 12 days: The demand lies in these words, In how many days will 16 men do the same? and the only term contained in it is 16 men.

The number sought here is the days in which 16 men will do the work, and the term in the supposition of the same kind is 12 days; therefore I place 12 days as the middle term, according to Rule I. the two remaining

terms are extremes, and of the same kind, viz. both of them men.

It is obvious that the answer must be less than the middle term; for 16 men will do the work in fewer days than 8 men; and therefore, by Rule II. the greatest extreme, viz. 16, is the divisor; which place on the left hand, and the other extreme on the right, as directed in Rule III. Then multiplying the second and third, and dividing their product by the first, the quot comes out in days; that is, of the same name with the middle term.

Men. days. men.  
 16 : 12 :: 8  
 8  
 ---  
 16)96(6 days. Ans.  
 96  
 ---  
 (0)

And because the extreme found in the demand happens to be the divisor, the proportion is inverse.

QUEST. 2. How much plush of 3 quarters wide will line a cloak that hath in it 4 yards of 7 quarters wide?

Here the answer must be greater than the middle term; for the plush being narrower than the cloth of which the cloak is made, will require more length.  
 Q. yds. Q.  
 3 : 4 :: 7.  
 7  
 ---  
 3)28(9 1/2 yards. Ans.  
 27  
 ---  
 (1)

QUEST. 3. If 36 yards be a rood of mason-work, at 3 feet high, how many yards will make a rood at 9 feet high?

Feet. yds. feet.  
 9 : 36 :: 3.  
 3  
 ---  
 9)108  
 ---  
 Ans. 12 yards.

SECT. II. The Compound Rule of Three.

THE Compound Rule of Three, from five given numbers finds a sixth, or from seven given numbers finds an eighth, or from eleven finds a twelfth, &c.

This rule easily and naturally admits of subdivisions, which, from the number of the terms given, may be denominated the rule of Five, the rule of Seven, the rule of Nine, the rule of Eleven, &c.

Questions in the Compound rule of three are also resolved into two parts, viz. a supposition and a demand.

If five terms be given, three of these are always found in the supposition, and two in the demand; if seven terms be given, four of these are in the supposition, and three in the demand; if nine terms are given, five of these are in the supposition, and four in the demand; if eleven terms be given, six of these are in the supposition, and five in the demand, &c.

The supposition and demand being distinguished, proceed to state the question; that is, to put the terms in due order for operation, as the following rules direct.

RULE I. Place that term of the supposition which is of the same kind with the number sought, in the middle.

The

The remaining terms are extremes, which must be classed into similar pairs, by making each pair consist of one term taken from the supposition, and another of the same kind taken from the demand.

II. Out of each similar pair, joined with the middle term, form a simple question; and in each simple question, so formed, find the divisor; *viz.* consider from the nature of the question, whether the answer must be greater or less than the middle term; and if the answer must be greater, the least extreme is the divisor; but if the answer must be less than the middle term, the greatest extreme is the divisor.

III. Place all the divisors on the left hand, and the other extremes on the right; then multiply the divisors, or extremes on the left, continually, for a divisor, and multiply the extremes on the right hand and the middle term, continually, for a dividend; and, lastly, divide the dividend by the divisor; and the quot is the answer, of the same name with the middle term.

The answer to questions in the compound rule of three may also be had by working the simple questions separately, or by themselves, in the following manner, *viz.*

The middle term, with any one pair of similar extremes, make the first simple question, and the answer to this question must be made the middle term to the next similar pair of extremes; and the answer to this second question, must in like manner be made the middle term to the following similar pair of extremes, &c.; and the answer to the last simple question is the number sought.

But the joint operation prescribed in Rule III. is the shorter as well as the easier method; for in working some of the simple questions, there may happen to be a remainder, and consequently the middle term of the next simple question will have some fractional part; which inconvenience is avoided by working jointly.

In every simple question, when the divisor is an extreme found in the supposition, the proportion is direct; but when the divisor is an extreme found in the demand, the proportion is inverse.

The three rules delivered above are indeed so calculated, as to make no difference between direct and inverse, or so as to render that distinction needless, the left-hand extremes being all divisors; but yet, as questions consisting entirely of direct proportions are the plainest and easiest, it will be proper, in the first place, to exemplify the rules by questions of the direct kind, and afterwards introduce such as are inverse.

And as questions in the rule of five are by far more numerous, and occur much oftener, than questions in the rule of seven, nine, or eleven; we shall, first of all, give questions in the rule of five, wherein both proportions are direct; then those wherein one or both proportions are inverse; and, lastly, give a few examples of the rules of seven, nine, and eleven.

I. *The Rule of Five Direct.*

QUEST. 1. If 14 horses eat 56 bushels of corn in

16 days, how many bushels will 20 horses eat in 24 days?

The supposition in this question is, If 14 horses eat 56 bushels in 16 days; and the three terms contained in it are, 14 horses, 56 bushels, and 16 days: The demand is, How many bushels will 20 horses eat in 24 days? and the two terms contained in it are 20 horses, and 24 days.

The number sought is bushels, and the term in the supposition of the same kind is 56 bushels; wherefore, according to Rule I. place 56 bushels in the middle. The remaining four terms are extremes, which you class into similar pairs, by making each pair consist of one term taken from the supposition, and another of the same kind taken from the demand. Thus, 14 horses, and 20 horses make one pair; again, 16 days, and 24 days make another pair.

Out of the several similar pairs, joined with the middle term, you form so many simple questions, according to Rule II. *viz.* by saying,

1. If 14 horses eat 56 bushels in a certain number of days, how many bushels will 20 horses eat in the same time?

2. If 16 days eat up, or consume, 56, or any other number of bushels, how many bushels will 24 days consume?

In the first simple question it is obvious, that the answer will be greater than the middle term; for 20 horses will eat more bushels than 14 horses will do in the same time; and so the least extreme, *viz.* 14, is the divisor; and because 14 is an extreme found in the supposition, the proportion is direct.

In the second simple question it is also plain, that the answer will be greater than the middle term; for 24 days will consume more bushels than 16 days; and consequently the least extreme, *viz.* 16, is the divisor; and because 16 is an extreme found in the supposition, the proportion is direct.

According to Rule III. place the divisors on the left hand, and the other extremes on the right, and both of them under one another, so that the two upper ones make a pair, or be of one kind, and the two lower ones make another pair, or be of one kind; and no matter which of the pairs be uppermost: then multiply the divisors, or the extremes on the left hand, for a divisor; and again, multiply the extremes on the right, and the middle terms, continually, for a dividend; and dividing the dividend by the divisor, the quot or answer comes out of the same name with the middle term, *viz.* 120 bushels.

<i>Joint operation.</i>	
<i>Horses.</i>	<i>bushels. horses.</i>
If 14 :	56 :: 20
da. 16	24 da.
<hr style="width: 50px; margin-left: 0;"/>	<hr style="width: 50px; margin-left: 0;"/>
84	480
14	56
<hr style="width: 50px; margin-left: 0;"/>	<hr style="width: 50px; margin-left: 0;"/>
224	288
	240
	<hr style="width: 50px; margin-left: 0;"/>
	224)26880(120
	<hr style="width: 50px; margin-left: 0;"/>
	448
	<hr style="width: 50px; margin-left: 0;"/>
	448
	<hr style="width: 50px; margin-left: 0;"/>

(c)  
*Ans.* 120 bushels.

The

The two simple questions into which the compound question is resolved, are stated, and wrought separately, as follows.

H. B.	H. Days.	B. Days.
If 14 : 56 :: 20	If 16 : 80 :: 24	
20	80	
14)1120(80 B.	16)1920(120 B.	
112	160	
(o)	32	
	32	
	(o)	

Ans. 120 bushels, as before.

II. The Rule of Five Inverse.

THE questions that fall under this rule have commonly one of the proportions inverse, and the other direct, and sometimes the upper, and sometimes the lower, is the inverse proportion; and in some few questions both proportions are inverse. Now, though the three rules delivered above make no difference betwixt direct and inverse; yet, to bring the learner to some measure of acquaintance with this useful distinction, we shall, in stating the following questions, expose the same to view, by affixing an asterisk to the extremes of every inverse proportion.

Quest. If 14 horses eat 56 bushels of corn in 16 days, in how many days will 20 horses eat 120 bushels at that rate?

In this question the supposition is, that 14 horses eat 56 bushels in 16 days; and the demand is, In how many days 20 horses will eat 120 bushels.

The number sought is days, and the term in the supposition of the same kind is 16 days; and accordingly place 16 days in the middle. The remaining four terms are extremes; which class into similar pairs, by making each pair consist of one term taken from the supposition, and another of the same kind taken from the demand. Thus, 14 horses and 20 horses make one pair; again, 56 bushels and 120 bushels make another pair.

Out of the similar pairs, joined with the middle term, form so many simple questions; namely,

1. If 14 horses eat a certain number of bushels in 16 days, in how many days will 20 horses eat the same quantity?

2. If 56 bushels are eat up in 16 days, in how many days will 120 bushels be eat up by the same eaters?

In the first simple question it is plain, that the answer must be less than the middle term; for 20 horses will eat the same number of bushels in fewer days than 14 horses; and so the greatest extreme, viz. 20, is the divisor; and because 20 is an extreme found in the demand, the proportion is inverse.

In the second simple question it is also obvious, that the answer must be greater than the middle term; for 120 bushels will require more days to be eat up in than 56 bushels; and therefore the least extreme, viz. 56, is the divisor; and because 56 is an extreme found in the supposition, the proportion is direct.

We now proceed to state the question, by placing the divisors on the left hand, and the other extremes on the right; then multiply and divide, as directed in Rule III. and the answer comes out of the same name with the middle term, viz. 24 days.

<i>Joint operation.</i>	
<i>Hors. days.</i>	<i>Hors. bush.</i>
* 20 : 16 :: 14	bush. 56
1120	1680
	16
	1008
	168
	--- days.
	112   0) 2688   0 (24 An.
	224
	448
	448
	(o)

The two simple questions into which the compound question is resolved, are stated and wrought separately, as follows.

<i>Hors. day.</i>	<i>hors.</i>	<i>Bush. d. h. m.</i>	<i>bush.</i>
* 20 : 16 :: 14*	56 : 11—4—48 :: 120		
14	24		
64	48		
16	22		
2 0)22 4 (11 days.	268		
24	60		
9 6(4 hours.	16128		
16	120		
60	6 0		
96 0(48 min.	56(1935360(3456 0		
	168....		
	--- 24)576(24 days.		
	255	48	
	224	96	
	313	96	
	280	(o)	
	336		
	336		
	(o)		

III. The Rule of Seven, Nine, &c.

QUEST. If 15 men eat 156 d. worth of bread in 6 days, when wheat is sold at 12 s. per bushel, in how many days will 30 men eat 520 d. worth of bread when wheat is at 10 s. per bushel?

This question belongs to the rule of seven, the number sought is days, and the term of the same kind in the supposition is 6 days, which place in the middle. The remaining six terms are extremes, which class into similar pairs, by taking one term of each pair out of the supposition, and another of the same kind out of the demand.

Out of the similar pairs, joined with the middle term, form so many simple questions, in each of which you find the divisor by Rule II.; then place the divisors on the left hand, and the other extremes on the right, as directed in Rule III. and multiply and divide, as follows.

*Joint operation.*

s.	*	30	:	6	::	15	*	s.
* 10	:	d. 156	:	520	d. :	12	*	
		4680		30		75		
		10		7800		12		
		46800		93600		6		
				46800		561600		

(12 days. *Ans.*)

This compound question is resolved into three simple ones, as follows.

$$30 : 6 :: 15 : 3$$

$$156 : 3 :: 520 : 10$$

$$10 : 10 :: 12 : 12 \text{ days. } \textit{Ans.}$$

EXAMP. If 100 lb. of Venice weigh 70 lb. of Lyons, and 120 lb. of Lyons weigh 100 lb. of Roan, and 80 lb. of Roan weigh 100 lb. of Toulouse, and 100 lb. of Toulouse weigh 74 lb. of Geneva, how many pounds of Geneva will 100 lb. of Venice weigh?

This question belongs to the rule of nine; and because pounds of Geneva is the number sought, the given pounds of Geneva, viz. 74, must be the middle term: the remaining terms are extremes; which may be classed into similar pairs, and stated as follows.

Ven. Ly.	100	74	::	100	Ly. Ven.
100	:	120	:	80	100
		8000		10000	
		120		70	
		960000		700000	
		100		100	
		96000000		70000000	
				74	
		96000000		518000000	
		480		538 2/3	
		380		288	
		(92)			

(53 2/3 lb of Geneva. *Ans.*)

But the question becomes more simple, and is wrought with greater ease and advantage, by being stated in the fractional form, as follows.

$$\frac{100 \times 70 \times 100 \times 100 \times 74}{100 \times 120 \times 80 \times 100} = \frac{70 \times 100 \times 74}{120 \times 80}$$

$$\frac{7 \times 10 \times 74}{12 \times 8} = \frac{5180}{96} = 53 \frac{2}{3} \text{ lb. of Geneva. } \textit{Ans.}$$

We shall conclude by observing, that every compound question, whether in the rule of five, seven, nine, or eleven, &c. properly speaking, consists but of three given terms. For the first term, or divisor, is to be considered as one compound term made up, or produced, by the continual multiplication of the extremes on the left hand, as so many component parts. In like manner, the third term is to be considered as one compound term, made up by the continual multiplication of the extremes on the right, as component parts. Suppose the question to be,

If L. 100 in 12 months gain L. 5 interest, what will L. 75 gain in 19 months?

Here it is obvious, that it is neither the L. 100 principal, nor the 12 months of time, taken separately, that gains the L. 5 interest, but both contribute their share; that is, they conspire, as joint causes, to produce one effect; and therefore their product, viz. the first term, is to be considered as the cause producing the effect; that is, the first term, viz. 100 x 12, causeth, produceth, or gains L. 5 of interest. And in like manner, the product of the extremes on the right hand, or the third term, viz. 75 x 9, is to be esteemed the cause that produceth a similar effect; that is, gains a like sum of interest, namely, the fourth term, or answer. In reference to this way of considering the first and third terms, the question might be stated as under.

$$\text{If } 100 \times 12 : 5 :: 75 \times 9$$

### CHAP. VIII. FELLOWSHIP.

FELLOWSHIP, called also *Company*, or *Partnership*, is when two or more persons join their stocks, and trade together, dividing the gain or loss proportionally among the partners.

Fellowship is either without or with time, called also *Single* or *Double*.

#### I. Fellowship without time.

Questions in fellowship without time are wrought by the following proportion.

- As the total stock
- To the total gain or loss,
- So each man's particular stock
- To his share of the gain or loss.

*Quest.* A and B make a joint stock: A puts in 12l. and B 8l.; they gain 5l.: What is each man's share?

L.	Stock. gain. Stock.
A's stock 12	A. If 20 : 5 :: 12
B's stock 8	5
Total stock 20	2 0 5 0
Stock. gain. Stock.	A's gain 3l.
B. If 20 : 5 :: 8	
8	L.
2 0 4 0	A's gain 3
	B's gain 3
B's gain 2l.	Total gain 5 proof.

*Note 1.* When in any question there happen to be remainders, they must be reduced equally low, so as to be all of one name; and then their sum will be either equal to the divisor, or exactly double, triple, &c. of it: and accordingly 1, 2, 3, &c. carried from the sum of the remainders, and added to the particular gains, will make up the total gain; or the divisor will always divide the sum of the remainders exactly, and the quot added to the particular gains will give the total gain.

*Note 2.* When the partners have equal shares of stock or capital, their shares of gain, loss, or neat proceeds, is found readily by dividing the total gain, loss, &c. by the number of partners.

II. Fellowship with time.

In fellowship with time, the gain or loss is divided among the partners, both in proportion to the stocks themselves, and also in proportion to the times of their continuance in company: For the same stock continued a double time, procures a double share of gain; and continued a triple time, procures a triple share of gain; that is, the shares of gain or loss are as the products of the several stocks multiplied into their respective times: and accordingly questions belonging to this rule are wrought by the following proportion.

As the sum of the products of the several stocks into their respective times

To the total gain or loss,

So the product of each man's stock into his time

To his share of the gain or loss:

*Quest. 1.* A put into company 40l for 3 months, B 75l. for 4 months; they gain 70l.: What share must each man have?

A  $40 \times 3 = 120$ , third term for A's share.

B  $75 \times 4 = 300$ , third term for B's share.

420, first term.

L.	L.
A. If 420 : 70 :: 120	B. If 420 : 70 :: 300
120	300
42 0 84 0 0(20l.	42 0 2100 0(50l.
84	210
(r)	(o)
A's gain 20	
B's gain 50	
Total gain 70 proof.	

*Quest. 2.* A put into company 560l. for 8 months, B 279l. for 10 months, and C 735l. for 6 months; they gained 1000l.: What share of the gain must each have?

A  $560 \times 8 = 4480$ , third term for A's share.

B  $279 \times 10 = 2790$ , third term for B's share.

C  $735 \times 6 = 4410$ , third term for C's share.

11680, first term.

L.	L. s. d. f. Rem.
A. If 11680 : 1000 :: 4480	: 383—11—2—3—208
B. If 11680 : 1000 :: 2790	: 238—17—4—3—80
C. If 11680 : 1000 :: 4410	: 377—11—4—1—880

Proof 1000—00—0—0—1163.

CHAP. IX. VULGAR FRACTIONS.

A FRACTION is a part or parts of an unit, or of any integer or whole; and is expressed by two numbers, one above and the other below a line drawn between them; as,  $\frac{3}{4}$ .

The number under the line shews into how many parts the unit or integer is divided; and is called the denominator, because it gives name to the fraction: The number above the line shews or tells how many of these parts the fraction contains; and is therefore called the numerator.

In the fraction  $\frac{3}{4}$ l. a pound Sterling is the unit, integer, or whole; and the denominator 4 shews that the pound is broken or divided into four equal parts, viz. 4 crowns; and the numerator 3 shews that the fraction contains three of these parts, that is, three crowns; and so the value of this fraction is fifteen shillings.

*COR. 1.* Hence it follows, 1. When the numerator of a fraction is less than the denominator, the value of such a fraction is less than unity, or the integer. 2. When the numerator is equal to the denominator, the value of the fraction is exactly an unit or integer. 3. When the numerator is greater than the denominator, the value of the fraction is more than an unit; and so often as the denominator is contained in the numerator, so many units or wholes are contained in the fraction. If, therefore the numerator of a fraction be divided by the denominator, the quot will be a number of units or integers, and the remainder so many parts.

The numerator of a fraction is to be considered as a dividend, and the denominator as a divisor; and the fraction itself may be taken to denote the quotient.

*COR. 2.* From this view of a fraction, it is evident, that if the numerator and denominator of a fraction be either both multiplied or both divided by the same number, the products or quotients will retain the same proportion to one another; and consequently the new fraction thence arising will be of the same value with the given one. Thus the numerator and denominator of the fraction  $\frac{2}{3}$  multiplied by 2 produces  $\frac{4}{6}$ , and divided by 2 quots  $\frac{1}{1.5}$ , both which fractions are of the same value with  $\frac{2}{3}$ .

Fractions having 10, 100, 1000, or 1, with any number of ciphers annexed to it, for a denominator, are called

ed:

ed *decimal fractions*; and fractions having any other denominator are called *vulgar fractions*.

1. A proper fraction is that whose numerator is less than its denominator, and consequently is in value less than unity; as  $\frac{3}{7}$ .

2. An improper fraction is that whose numerator is equal to or greater than its denominator; and consequently is in value equal to or greater than an unit; as  $\frac{4}{2}$ ,  $\frac{7}{7}$ .

3. A simple fraction is that which has but one numerator, and one denominator; and may be either proper or improper; as  $\frac{1}{2}$  or  $\frac{2}{1}$ .

4. A compound fraction is made up of two or more simple fractions, coupled together with the particle *of*, and is a fraction of a fraction; as  $\frac{2}{3}$  of  $\frac{1}{4}$ , or  $\frac{1}{4}$  of  $\frac{2}{3}$  of  $\frac{1}{4}$ .

5. A mixt number consists of an integer, and a fraction joined with it; as  $7\frac{1}{2}$ .

Because in most cases fractions can neither be added nor subtracted, till they be reduced, we begin with reduction.

#### Reduction of Vulgar Fractions.

PROBLEM I. To reduce an improper fraction to an integer, or mixt number.

RULE. Divide the numerator by the denominator, the quot gives integers; and the remainder, if there be any, placed over the divisor or denominator, gives the fraction to be annexed.

#### EXAMPLES.

- $2\frac{3}{4} = 85$  integers, there being no remainder.
- $4\frac{1}{2} = 54\frac{1}{2}$ , the remainder being 5.
- $2\frac{1}{2} = 98\frac{1}{2}$ , the remainder being 10.
- $2\frac{1}{2} = 173\frac{4}{8}$ , the remainder being 48.

PROB. II. To reduce a mixt number to an improper fraction.

RULE. Multiply the integer by the denominator; to the product add the numerator: The sum is the numerator of the improper fraction; and the denominator is the same as before.

#### EXAMPLES.

- $54\frac{1}{2} = 4\frac{1}{2}$ ; for  $54 \times 8 = 432$   
 $\frac{1}{2} \times 8 = 4$   


---

 Numerator 437
- $98\frac{1}{2} = 1\frac{1}{2}$ ; for  $98 \times 14 = 1372$   
 $\frac{1}{2} \times 14 = 7$   


---

 Numerator 1382

PROB. III. To reduce a whole number to a fraction of a given denominator.

RULE. Multiply the whole number by the given denominator; and place the product by way of numerator over the given denominator.

#### EXAMPLES.

- Reduce 9 to a fraction whose denomination is 5.  
 $9 \times 5 = 45$ ; so the fraction is  $\frac{45}{5}$ .
- Reduce 36 to a fraction whose denominator is 4.  
 $36 \times 4 = 144$ ; so the fraction is  $\frac{144}{4}$ .
- Reduce 8 to a fraction whose denominator is 1.  
 $8 \times 1 = 8$ ; so the fraction is  $\frac{8}{1}$ .

The reason of the rule appears by reverfing the operation; for if the numerator be divided by the denominator, it will quot the integer, or whole number.

PROB. IV. To reduce a compound fraction to a simple one.

RULE. Multiply the numerators continually for the numerator of the simple fraction; and multiply the denominators continually for its denominator.

#### EXAMPLES.

Ex. 1.  $\frac{2}{3}$  of  $\frac{4}{7} = \frac{8}{21}$ . Ex. 2.  $\frac{1}{2}$  of  $\frac{1}{3}$  of  $\frac{1}{4} = \frac{1}{24}$ .

COR. From this problem may be deduced a method of reducing a fraction of a lesser denomination to a fraction of a greater denomination; namely,

Form a compound fraction, by comparing the given fraction with the superior denominations; and then reduce the compound fraction to a simple one.

#### EXAMPLES.

- What fraction of a pound Sterling is  $\frac{1}{2}$  of a penny?  
 $\frac{1}{2}$  d. is  $\frac{1}{12}$  of  $\frac{1}{20}$  of  $\frac{1}{20}$  L. =  $\frac{1}{480}$  L.
- What fraction of a C. is  $\frac{1}{2}$  of a pound?  
 $\frac{1}{2}$  lb. is  $\frac{1}{4}$  of  $\frac{1}{4}$  of  $\frac{1}{4}$  C. =  $\frac{1}{64}$  C.

PROB. V. To reduce a fraction of a greater denomination to a fraction of a lesser denomination.

RULE. Multiply the numerator of the given fraction, as in reduction of integers descending; and the product is the numerator, to be placed over the denominator of the given fraction.

#### EXAMPLES.

- What fraction of a shilling is  $\frac{1}{2}$  of a pound?  
 Here, as in reduction descending, multiply the numerator 3 by 20, because 20 shillings make a pound; as under.

$$\begin{array}{r} L. \\ 3 \times 20 = 60 \\ \hline 4 \end{array} = 60 \text{ shilling.}$$

- What fraction of a penny is  $\frac{1}{2}$  L.?

$$\begin{array}{r} L. \\ 4 \times 20 \times 12 = 960 \\ \hline 5 \end{array} = 960 \text{ d.}$$

The reason of this rule will appear by observing, that every fraction may be considered in two views. Thus,  $\frac{1}{4}$  may either be considered as expressing three fourths of one unit, or as denoting the fourth part of three units. Now, if the unit be a pound Sterling, the fraction, in the latter view, will denote the fourth part of three pounds; and by reducing the numerator L. 3 to shillings, we have  $60$  s.; and again reducing 60 shillings to pence, we have  $720$  d. equal to  $60$  s. or to  $\frac{1}{2}$  L.

PROB. VI. To find the value of a fraction.

RULE. Reduce the numerator to the next inferior denomination; divide by the denominator; and the quot, if nothing remain, is the value complete.

If there be any remainder, it is the numerator of a fraction whose denominator is the divisor. This fraction may either be annexed to the quotient, or reduced to value, if there be any lower denomination.

EXAMP.

EXAMP. What is the value of  $\frac{1}{4}$  L. ?

EXAMPLES.

$$\begin{array}{r} 3 \\ 20 \\ \hline 4)60(15 \text{ s.} \end{array}$$
 Here consider  $\frac{1}{4}$  L. as expressing the fourth part of three pounds Sterling; so reduce L 3, the numerator, to shillings, and divide by the denominator 4; and as nothing remains, the quot, viz. 15 shillings, is the value complete.

(o)  
L. s.  
 $\frac{1}{4} = 15$

The reason of this rule is the same with that in the preceding problem. It is by the practice of this problem that remainders in the rule of three are reduced to value.

PROB. VII. To reduce a fraction to its lowest terms.

RULE. Divide both numerator and denominator by their greatest common divisor; the two quots make the new fraction.

The greatest common divisor of the numerator and denominator of a fraction is found by the following

RULE. Divide the greater of these two numbers by the lesser; and again divide the divisor by the remainder; and so on, continually, till 0 remains. The last divisor is their greatest common divisor.

EXAMP. Reduce  $\frac{784}{952}$  to its lowest terms.

First find the greatest common divisor of the numerator and denominator, as follows

$$\begin{array}{r} 784)952(1 \\ \underline{784} \\ 168)784(4 \\ \underline{672} \\ 112)168(1 \\ \underline{112} \\ 56)112(2 \\ \underline{112} \\ 0 \end{array}$$

Greatest common divisor 56

Then proceed to reduce the given fraction to its lowest terms, by dividing both numerator and denominator by 56, the great common divisor.

$$\begin{array}{r} 56)784(14 \text{ new num.} \\ \underline{56} \\ 224 \\ \underline{224} \\ 0 \end{array} \qquad \begin{array}{r} 56)952(17 \text{ new denom.} \\ \underline{56} \\ 392 \\ \underline{392} \\ 0 \end{array}$$

So  $\frac{784}{952} = \frac{14}{17}$ .

PROB. VIII. To reduce fractions of different denominators to a common denominator.

RULE. Multiply the denominators continually for the common denominator; and multiply each numerator into all the denominators, except its own, for the several numerators.

Reduce  $\frac{1}{4}$  and  $\frac{1}{5}$  to a common denominator.

$4 \times 5 = 20$ , the common denominator.

$3 \times 5 = 15$ , the first numerator.

$4 \times 4 = 16$ , the second numerator.

So the new fractions are  $\frac{15}{20}$  and  $\frac{16}{20}$ .

When the denominator of one fraction happens to be an aliquot part of the denominator of another fraction, the former may be reduced to the same denominator with the latter, by multiplying both its numerator and denominator by the number which denotes how often the lesser denominator is contained in the greater.

Thus,  $\frac{1}{2} + \frac{1}{4} = \frac{2}{4} + \frac{1}{4}$ .

Here 3 is contained in 12 four times; so multiply both 2 and 3 by 4, and you have  $\frac{8}{12} = \frac{2}{3}$ .

Again,  $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} = \frac{4}{8} + \frac{2}{8} + \frac{1}{8}$ .

Sometimes too, the fraction that has the greater denominator may, in like manner, be reduced to the same denominator with that which has the lesser, by division.

Thus,  $\frac{1}{2} + \frac{1}{3} = \frac{1}{2} + \frac{1}{3}$ .

And  $\frac{1}{2} + \frac{1}{3} + \frac{1}{4} = \frac{2}{4} + \frac{1}{4} + \frac{1}{4}$ .

The reason of the above rule for reducing fractions to a common denominator is evident from Corollary II.; for both numerator and denominator of every fraction are multiplied by the same number, or by the same numbers.

After fractions are reduced to a common denominator, they may frequently be reduced to lower terms, by dividing all the numerators, and also the common denominator, by any divisor that leaves no remainder, or by cutting off an equal number of ciphers from both.

Addition of Vulgar Fractions.

RULE I. If the given fractions have all the same denominator, add the numerators, and place the sum over the denominator.

EX. 1. What is the sum of  $\frac{1}{2} + \frac{1}{4}$ ? Ans.  $\frac{3}{4}$ .

2. What is the sum of  $\frac{1}{3} + \frac{1}{6}$ ? Ans.  $\frac{2}{6} = \frac{1}{3}$ , by Prob. VII.

RULE II. If the given fractions have different denominators, reduce them to a common denominator, by Prob. VIII. then add the numerators, and place the sum over the common denominator.

EX. What is the sum of  $\frac{1}{2} + \frac{1}{4}$ ?

$\frac{1}{2} + \frac{1}{4} = \frac{2}{4} + \frac{1}{4}$ , by Prob. VIII.

and  $\frac{2}{4} + \frac{1}{4} = \frac{3}{4}$ .

RULE III. If mixt numbers be given, or if mixt numbers and fractions be given, reduce the mixt numbers to improper fractions, by Prob. II.; then reduce the fractions to a common denominator, by Prob. VIII. and add the numerators.

EX. What is the sum of  $7\frac{1}{2} + 5\frac{1}{3}$ ?

$7\frac{1}{2} + 5\frac{1}{3} = \frac{14}{2} + \frac{17}{3}$ , by Prob. II.

and  $\frac{14}{2} + \frac{17}{3} = \frac{28}{3} + \frac{17}{3}$ , by Prob. VIII.

and  $\frac{28}{3} + \frac{17}{3} = \frac{45}{3} = 15$ , by Prob. I.

When mixt numbers, or mixt numbers and fractions, are given, you may, with greater expedition, work by the following rule, viz. reduce only the fractions to a common denominator, and add the sum of the fractions

to the integers. The above example wrought in this manner follows.

Ex. What is the sum of  $7\frac{1}{2} + 5\frac{2}{3}$ ?

$$\frac{1}{2} + \frac{2}{3} = \frac{3}{6} + \frac{4}{6} = \frac{7}{6} = 1\frac{1}{6}.$$

$$\text{and } 7 + 5 + 1\frac{1}{6} = 13\frac{1}{6}.$$

RULE IV. If any, or all of the given fractions; be compound, first reduce the compound fractions to simple ones, by Prob. IV.; then reduce the simple fractions to a common denominator, by Prob. VIII. and add the numerators.

Ex. What is the sum of  $\frac{2}{3}$  of  $\frac{1}{2}$  +  $\frac{1}{4}$ ?

$$\frac{2}{3} \text{ of } \frac{1}{2} = \frac{1}{3}, \text{ by Prob. IV.}$$

$$\text{and } \frac{1}{3} + \frac{1}{4} = \frac{4}{12} + \frac{3}{12} = \frac{7}{12}, \text{ by Prob. VIII.}$$

$$\text{and } \frac{1}{3} + \frac{1}{4} = \frac{4}{12} + \frac{3}{12} = \frac{7}{12} = 1\frac{7}{12}, \text{ by Prob. I.}$$

RULE V. If the given fractions be of different denominations, first reduce them to the same denomination, by Cor. of Prob. IV. or by Prob. V.; then reduce the fractions, now of one denomination, to a common denominator, by Prob. VIII. and add the numerators; or reduce each of the given fractions separately to value, by Prob. VI. and then add their values.

Ex. What is the sum of  $\frac{1}{2}$  s. and  $\frac{3}{4}$  l.?

METHOD I.

$$\frac{1}{2} \text{ s.} = \frac{1}{2} \text{ of } 1 \text{ l.} = \frac{1}{2} \text{ l. by Cor. Prob. IV.}$$

$$\text{and } \frac{1}{2} \text{ l.} + \frac{3}{4} \text{ l.} = \frac{2}{4} \text{ l.} + \frac{3}{4} \text{ l.} = \frac{5}{4} \text{ l. by Prob. VIII.}$$

$$\text{and } \frac{2}{4} \text{ l.} + \frac{3}{4} \text{ l.} = \frac{5}{4} \text{ l.} = 1 \text{ s. } 3 \text{ d. by Prob. VI.}$$

METHOD II.

$$\frac{1}{2} \text{ l.} = \frac{7 \times 20}{8} \text{ s.} = 17\frac{5}{8} \text{ s. by Prob. V.}$$

$$\text{and } \frac{1}{2} + \frac{3}{4} = \frac{2}{4} + \frac{3}{4} = \frac{5}{4}, \text{ by Prob. VIII.}$$

$$\text{and } \frac{5}{4} + 17\frac{5}{8} \text{ s.} = 18\frac{5}{8} \text{ s. by Prob. I. and VI.}$$

METHOD III.

$$\frac{1}{2} \text{ s.} = \frac{3 \times 12}{4} \text{ d.} = 9 \text{ d.}$$

$$\frac{3}{4} \text{ l.} = \frac{7 \times 20}{8} \text{ s.} = 17\frac{5}{8} \text{ s.} = 17 - 6$$

$$\frac{18 - 3}{8} \text{ s.} \quad \left. \begin{array}{l} \text{d.} \\ \text{s.} \end{array} \right\} \text{ by Prob. VI.}$$

Subtraction of Vulgar Fractions.

RULE I. If the given fractions have the same denominator, subtract the lesser numerator from the greater, and place the remainder over the denominator.

Ex. From  $\frac{1}{2}$  subtract  $\frac{1}{3}$ .

$$\frac{1}{2} - \frac{1}{3} = \frac{1}{6}.$$

RULE II. If the given fractions have different denominators, reduce them to a common denominator, by Prob. VIII.; then subtract the lesser numerator from the greater, and place the remainder over the common denominator.

Ex. From  $\frac{1}{2}$  subtract  $\frac{2}{3}$ .

$$\frac{1}{2}, \frac{2}{3} = \frac{3}{6}, \frac{4}{6}, \text{ by Prob. VIII.}$$

$$\text{and } \frac{3}{6} - \frac{4}{6} = -\frac{1}{6}.$$

RULE III. If it be required to subtract one mixt number from another, or to subtract a fraction from a mixt number, reduce the mixt numbers to improper

fractions, by Prob. II; then reduce the fractions to a common denominator, by Prob. VIII. and subtract the one numerator from the other.

Ex. From  $7\frac{1}{2}$  subtract  $5\frac{2}{3}$ .

$$7\frac{1}{2}, 5\frac{2}{3} = \frac{14}{2}, \frac{10}{3}, \text{ by Prob. II.}$$

$$\text{and } \frac{14}{2}, \frac{10}{3} = \frac{63}{6}, \frac{40}{6}, \text{ by Prob. VIII.}$$

$$\text{and } \frac{63}{6} - \frac{40}{6} = \frac{23}{6} = 3\frac{5}{6}, \text{ by Prob. I. and VII.}$$

RULE IV. If it be required to subtract a mixt number, or a fraction, from an integer, first subtract the fraction from an unit borrowed; that is, subtract the numerator from the denominator, and place the remainder, as a numerator, over the denominator, for the fractional part of the answer: Then, for the unit borrowed, add 1 to the integral part of the mixt number; subtract the sum from the given integer; and prefix the remainder to the fractional part of the answer. But when a fraction is subtracted from an integer, for the unit borrowed, take 1 from the given integer, and prefix the remainder to the fractional part of the answer.

Ex. 1. From 14 subtract  $7\frac{2}{3}$ .

Here say,  $5 - 3 = 2$ ; so  $\frac{2}{3}$  is the fractional part of the answer: Then say, 1 borrowed and 7 make 8, and 8 subtracted from 14 leaves 6; which prefix to the fractional part: So the difference or answer is  $6\frac{2}{3}$ .

Ex. 2. From 12 subtract  $\frac{1}{4}$ .

Here say,  $7 - 3 = 4$ ; so  $\frac{4}{4}$  is the fractional part; then say, 1 borrowed from 12, and 11 remains: So  $11\frac{4}{4}$  is the difference, or answer.

Note, When an integer is given to be subtracted from a mixt number, you have only to subtract the given integer from the integral part of the mixt number; and to the remainder annex the fractional part. Thus,  $9\frac{1}{2} - 5 = 4\frac{1}{2}$ .

RULE V. If one or both of the given fractions be compound, first reduce the compound fractions to simple ones, by Prob. IV.; then reduce the simple fractions to a common denominator, by Prob. VIII.; and subtract the one numerator from the other.

Ex. From  $\frac{1}{2}$  subtract  $\frac{2}{3}$  of  $\frac{1}{4}$ .

$$\frac{2}{3} \text{ of } \frac{1}{4} = \frac{1}{6}, \text{ by Prob. IV.}$$

$$\text{and } \frac{1}{2}, \frac{1}{6} = \frac{3}{6}, \frac{1}{6}, \text{ by Prob. VIII.}$$

$$\text{and } \frac{3}{6} - \frac{1}{6} = \frac{2}{6} = \frac{1}{3}, \text{ by Prob. VII.}$$

RULE VI. When the given fractions are of different denominations, first reduce them to the same denomination, by Cor. of Prob. IV. or by Prob. V., then reduce the fractions, now of one denomination, to a common denominator, by Prob. VIII.; and subtract the one numerator from the other. Or, reduce each of the given fractions, separately, to value, by Prob. VI.; and subtract the one value from the other.

Ex. From  $\frac{1}{2}$  l. subtract  $\frac{3}{4}$  s.

METHOD I.

$$\frac{3}{4} \text{ s.} = \frac{3}{4} \text{ of } \frac{1}{2} \text{ l.} = \frac{3}{8} \text{ l. by Cor. Prob. IV.}$$

$$\text{and } \frac{1}{2}, \frac{3}{8} = \frac{4}{8}, \frac{3}{8}, \text{ by Prob. VIII.}$$

$$\text{and } \frac{4}{8} - \frac{3}{8} = \frac{1}{8} \text{ l.} = 1 \text{ s. } 4 \text{ d. by Prob. I. and VI.}$$

METHOD II.

$$\frac{1}{2} \text{ l.} = \frac{3 \times 20}{4} \text{ s.} = 15 \text{ s. by Prob. V.}$$

$$\text{and } \frac{3}{4}, \frac{1}{2} = \frac{15}{20}, \frac{10}{20}, \text{ by Prob. VIII.}$$

$$\text{and } \frac{15}{20} - \frac{10}{20} = \frac{5}{20} \text{ s.} = 1 \text{ s. } 4 \text{ d. by Prob. I. and VI.}$$

METHOD



METHOD III.

$$\left. \begin{array}{l} 1. \frac{3 \times 20}{4} s. = 60 s. = 15 - 0 \\ \frac{2 \times 12}{3} d. = 8 d. = \quad 8 \end{array} \right\} \text{by Prob. VI.}$$

$$14 - 4$$

Multiplication of Vulgar Fractions.

In multiplication of fractions there is no occasion to reduce the given fractions to a common denominator, as in addition and subtraction: only if a mixt number be given, reduce it to an improper fraction; if an integer be given, reduce it to an improper fraction, by putting an unit for its denominator; if a compound fraction be given, you may either reduce it to a simple one, or, instead of the particle *of*, insert the sign of multiplication: then work by the following

**RULE.** Multiply the numerators for the numerator of the product, and multiply the denominators for its denominator.

**EXAMP. 1.**  $\frac{2}{3} \times \frac{4}{7} = \frac{8}{21}$

2.  $\frac{1}{2} \times 5\frac{1}{7} = \frac{1}{2} \times \frac{37}{7} = \frac{37}{14} = 4\frac{1}{14} = 4\frac{1}{2}$

**Note 1.** If any number be multiplied by a proper fraction, the product will be less than the multiplicand; for multiplication is the taking of the multiplicand as often as the multiplier contains unity; and consequently, if the multiplier be greater than unity, the product will be greater than the multiplicand; if the multiplier be unity, the product will be equal to the multiplicand; and if the multiplier be less than unity, the product will, in the same proportion, be less than the multiplicand. Thus, supposing the multiplier to be  $\frac{1}{2}$  or  $\frac{1}{3}$ , the product, in this case, will be equal to one half or to one third of the multiplicand.

2. Mixt numbers may be multiplied without reducing them to improper fractions, by working as in the margin; where first multiply the integral parts, *viz.* 54 by 24; then multiply the integral parts cross-ways into their altera fractions, *viz.* 54 by  $\frac{1}{2}$ , and the product 27 set down; in like manner multiply 24 by  $\frac{1}{2}$ , and the product 6 likewise set down; then add; and to the sum annex  $\frac{1}{2}$ , the product of the two fractions.

3. In multiplying a fraction by an integer, you have only to multiply the numerator by the integer, the putting one for the denominator being only matter of form. And to multiply a fraction by its denominator is to take away the denominator, the product being an integer, the same with, or equal to the numerator. Thus,  $\frac{7}{2} \times 8 = 7$ . For  $\frac{7}{2} \times \frac{2}{2} = \frac{7}{1} = 7$ .

4. If the numerators and denominators of two equal fractions be multiplied cross-ways, the products will be equal. Thus, if  $\frac{3}{4} = \frac{9}{12}$ , then will  $3 \times 12 = 9 \times 4$ ; for multiplying both by 9, we have  $3 = \frac{9 \times 4}{12}$ ; and multiplying these by 12, we have  $3 \times 12 = 9 \times 4$ . Hence, if four numbers be proportional, the product of the extremes will be equal to the product of the means: for if

$3 : 9 :: 4 : 12$ , then  $\frac{3}{4} = \frac{9}{12}$ ; and it has been proved, that  $3 \times 12 = 9 \times 4$ . Therefore if, of four proportional numbers, any three be given, the fourth may easily be found, *viz.* when one of the extremes is sought, divide the product of the means by the given extreme; and when one of the means is sought, divide the product of the extremes by the given mean.

5. In multiplying fractions, equal factors above and below may be dashed or dropt. Thus,  $\frac{1}{2}$  of  $\frac{2}{3} \times \frac{3}{4}$  of  $\frac{4}{5} = \frac{1}{2} \times \frac{2}{3} \times \frac{3}{4} \times \frac{4}{5}$ ; and dropping the factors 2, 3, 4, both above and below, the product is  $\frac{1}{5}$ . In like manner, to facilitate an operation, a factor above and another below may be divided by the same number: Thus,

$\frac{6}{7} \times \frac{5}{14} = \frac{1}{7} \times \frac{5}{2} = \frac{5}{14}$ . Or we may exchange one numerator for another: Thus,  $\frac{6}{7} \times \frac{5}{14} = \frac{6}{14} \times \frac{5}{7} = \frac{3}{7} \times \frac{5}{7} = \frac{15}{49}$ .

6. To take any part of a given number, is to multiply the said number by the fraction. Thus,  $\frac{2}{3}$  of 320 is found thus,  $\frac{2}{3} \times \frac{320}{1} = \frac{2}{3} \times \frac{320 \times 3}{3} = \frac{2}{3} \times 960 = \frac{2 \times 960}{3} = 640$ . In like manner,  $\frac{1}{3}$  of  $45\frac{1}{2}$ , is  $\frac{1}{3} \times 45\frac{1}{2} = \frac{1}{3} \times \frac{91}{2} = \frac{91}{6} = 15\frac{1}{6}$ . Hence, to reduce a compound fraction to a simple one, is to multiply the parts of it into one another.

7. If a multiplicand of two or more denominations be given to be multiplied by a fraction, reduce the higher part or parts of the multiplicand to the lowest species, and then multiply. Thus, to multiply 8 l. 10 s. by  $\frac{2}{3}$ , say,  $8 l. = 8 \times 20 s. = 160 s.$  and  $160 + 10 = 170 s. = \frac{68}{4} l.$  and  $\frac{2}{3} \times \frac{68}{4} = \frac{136}{12} = 11\frac{4}{3} s. = L. 5 : 13 : 10$ . Or, without reducing, you may multiply the given multiplicand by the numerator of the fraction, and divide the product by the denominator.

- EXAMP. 1.** Multiply  $\frac{2}{3}$  by  $\frac{2}{7}$ . Prod.  $\frac{4}{21}$ .  
 2. Multiply  $7\frac{2}{3}$  by  $\frac{4}{7}$ . Prod.  $6\frac{2}{3}$ .  
 3. Multiply  $8\frac{2}{3}$  by  $9\frac{1}{2}$ . Prod.  $84\frac{1}{2}$ .

The reason of the rule may be shewn thus:  $\frac{2}{3} \times \frac{4}{7} = \frac{8}{21}$ ; for  $\frac{2}{3} = \frac{2 \times 2}{3 \times 2} = \frac{4}{6}$ , and  $\frac{4}{7}$  of  $\frac{4}{7}$  is  $\frac{4}{21}$ ; and consequently  $\frac{2}{3}$  of  $\frac{4}{7}$  is  $\frac{8}{21}$ .

The truth of the rule may also be proved thus: Assume two fractions equal to two integers, such as,  $\frac{2}{3}$ , and  $\frac{4}{6}$ , equal to 2 and 3, and the product of the fractions will be equal to the product of the integers; for  $\frac{2}{3} \times \frac{4}{6} = \frac{8}{18} = \frac{4}{9}$ , and  $2 \times 3 = 6$ .

Division of Vulgar Fractions.

In division of fractions, if a mixt number be given, reduce it to an improper fraction; if an integer be given, put an unit for its denominator; if a compound fraction be given, reduce it to a simple one, and then work by the following

**RULE.** Multiply cross-ways, *viz.* the numerator of the divisor into the denominator of the dividend, for the denominator of the quot; and the denominator of the divisor into the numerator of the dividend, for the numerator of the quot.

- EXAMP. 1.**  $\frac{2}{3} \div \frac{4}{7} (\frac{2}{3} = 1\frac{2}{3} = 1\frac{1}{2})$   
 2.  $\frac{1}{2} \div 4\frac{1}{2} (= \frac{1}{2}) \frac{1}{2} (\frac{6}{2} = 5\frac{1}{2} = 5\frac{1}{2})$   
 3.  $4\frac{2}{3} \div \frac{7}{8} (= 1\frac{2}{3}) \frac{7}{8} (\frac{21}{8} = 2\frac{5}{8})$

Note.

Note 1. Instead of working division of fractions as taught above, you may invert the divisor, and then multiply it into the dividend. Thus, in Example 1. instead of  $\frac{1}{3})\frac{4}{15}$ , you may say,  $\frac{1}{3} \times \frac{4}{15} = \frac{4}{45} = 1\frac{1}{15}$ .

2. If any number be divided by a proper fraction, the quot will be greater than the dividend: for in division the quot shews how often the divisor is contained in the dividend; and consequently if the divisor be greater than unity, the quot will be less than the dividend; if the divisor be unity, the quot will be equal to the dividend; and if the divisor be less than unity, the quot will, in the same proportion, be greater than the dividend. Thus, supposing the divisor to be  $\frac{1}{2}$ , or  $\frac{1}{3}$ , the quot in this case will be double or triple of the dividend.

3. To divide a fraction by an integer, is only to multiply the integer into the denominator of the fraction, the numerator being continued. Thus,  $7)\frac{1}{3} = \frac{7}{3}$ .

4. A mixt number may sometimes be divided by an integer, with more ease, in the following manner. Divide the integral part of the mixt number by the given integer: and if there be no remainder, divide likewise the fraction of the mixt number by the given integer, and annex the quot to the integral quot formerly found. But if, in dividing the integral part, there happen to be a remainder, prefix this remainder to the fraction for a new mixt number; which reduce to an improper fraction: then divide the improper fraction by the given integer, and annex the quot to the integral quot formerly found. Thus, if it be required to divide  $15\frac{1}{2}$  by 8, say, 8)15(1, and 7 remains; which 7, prefixed to the fraction, gives  $7\frac{1}{2}$  for a new mixt number; and this, reduced to an improper fraction, is  $\frac{15}{2}$ , and  $8)\frac{15}{2} = \frac{15}{2} \div 8 = \frac{15}{16}$ : so the complete quot is  $1\frac{7}{8}$ .

5. If the factors of the numerator and denominator of the quots, instead of being actually multiplied, be only connected with the sign of multiplication, it will be easy to drop such factors, above and below, as happen to be the same, thus:  $\frac{1}{4})\frac{4}{3}$  of  $\frac{4 \times 4 \times 3}{3 \times 5 \times 8} = \frac{4 \times 4}{5 \times 8} = \frac{2}{5}$ . Or a factor above and below may be divided by the same number thus:  $\frac{1}{5})\frac{7}{12}$  ( $\frac{6 \times 7}{5 \times 12} = \frac{7}{5 \times 2} = \frac{7}{10}$ . Or the factors of the numerator of the quot may be exchanged, thus:  $\frac{3}{7})\frac{5}{2}$  ( $\frac{3 \times 5}{2 \times 9} = \frac{5 \times 3}{2 \times 9} = \frac{5}{2 \times 3} = \frac{5}{6}$ .

6. To divide an integer by a fraction, is to divide the product of the denominator and integer by the numerator, thus:  $\frac{4}{7})8$  ( $\frac{5 \times 8}{4} = 5 \times 2 = 10$ .

7. If the divisor and dividend have the same denominator, you have only to divide the numerator of the dividend by the numerator of the divisor, thus:  $\frac{4}{7})\frac{1}{7} = \frac{1}{7}$ ; for  $\frac{4}{7})\frac{8 \times 3}{5 \times 8} = \frac{1}{7}$ .

8. If a dividend of two or more denominations be given to be divided by a fraction, reduce the higher part or parts of the dividend to the lowest species, and then divide. Thus, to divide 6l. 9s. by  $\frac{1}{3}$ , say,  $6l. = 6 \times 20s. = 120$ ; and  $120 + 9s. = 129\frac{1}{4}s. = \frac{519}{4}$ ; and  $\frac{1}{3})\frac{519}{4} = \frac{519}{12} = 19\frac{3}{4}s. = 9l. 14s. 7\frac{1}{2}d.$

Or, Divide the given multiplicand by the numerator of the fraction, and multiply the quot by the denominator.

EXAMP. Divide L. 276 : 16 : 8 among four men, A, B, C, D, so that A, B, C, may have equal shares, and D only two thirds of one of their shares.

$$1 + 1 + 1 + \frac{2}{3} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3} + \frac{2}{3} = \frac{5}{3}$$

L.	s.	d.	L.	s.	d.
11) 276	16	8	(25	3	4
			$\times 3 =$	75	10
			$\times 3 =$	75	10
			$\times 3 =$	75	10
			$\times 2 =$	50	6
				8	D.

Proof 276 16 8

The reason of the rule will appear by considering, that the method here used is nothing else but the reducing the divisor and dividend to a common denominator, and then dividing the one numerator by the other. Thus,  $\frac{1}{3})\frac{2}{3}$  ( $\frac{2}{9}$ , for reducing the divisor and dividend to a common denominator, we have  $\frac{2}{9} \div \frac{1}{3} = \frac{2}{3}$ .

The truth of the rule may also be proved by assuming two fractions equal to two integers, such as,  $\frac{6}{7}$  and  $\frac{16}{7}$ , equal to 2 and 4, and the quot of the fractions will be equal to the quot of the integers. Thus,  $\frac{6}{7} \div \frac{16}{7} = \frac{3}{8}$  = 2, and  $2)4(2$ .

The Simple Rule of Three in Vulgar Fractions.

The question is stated as formerly taught in the rule of three. The extremes must be of one denomination. Reduce mixt numbers and integers to improper fractions, compound fractions to simple ones, and then work by the following rule, viz.

Multiply the second and third terms, and divide the product by the first term; that is, multiply the numerator of the first term into the denominators of the second and third, for the denominator of the answer; and multiply the denominator of the first term into the numerators of the second and third, for the numerator of the answer.

I. Direct.

QUEST. If  $\frac{1}{4}$  yard cost  $\frac{1}{5}l.$  what will  $\frac{2}{3}$  yard cost?

Yd. L. Yd.

If  $\frac{1}{4} : \frac{1}{5} :: \frac{2}{3} :$

Ans.  $\frac{4 \times 5 \times 9}{3 \times 8 \times 10} = \frac{5 \times 9}{3 \times 2 \times 10} = \frac{9}{2 \times 2 \times 2} = \frac{3}{4}$  =  $\frac{3}{4}l.$  =  $\frac{3 \times 20}{4}s. = 60 = 15s.$

II. Inverse.

QUEST. If  $\frac{1}{4}$  yard of cloth that is 2 yards wide, will make a garment, how much of any other cloth that is  $\frac{1}{3}$  yard wide will make the same garment?

Bread. len. Bread.

$\frac{1}{4} : 2 :: \frac{1}{3} :$

Ans.  $\frac{5 \times 3 \times 2}{3 \times 4 \times 1} = \frac{5 \times 2}{4} = \frac{5}{2} = 2\frac{1}{2}$  yards.

The Compound Rule of Three in Vulgar Fractions.

QUEST. If  $\frac{1}{2}$  acre of grass be cut down by 2 men in  $\frac{1}{3}$  day, how many acres shall be cut down by 6 men in  $3\frac{1}{3}$  days?

Men. acr. men.  
 $\frac{2}{1} : \frac{1}{2} :: \frac{6}{1}$   
 day  $\frac{1}{3} : \frac{1}{3} :: \frac{3\frac{1}{3}}{1}$  days.  
 $\frac{1}{3} : \frac{1}{3} :: \frac{1}{1}$   
 Ans.  $\frac{3 \times 3 \times 60}{4 \times 4 \times 3} = \frac{3 \times 60}{4 \times 4} = \frac{3 \times 15}{4} = 11\frac{1}{4}$  act.  
 Or thus:  
 Ans.  $\frac{3 \times 1 \times 3 \times 6 \times 10}{2 \times 2 \times 4 \times 1 \times 3} = \frac{3 \times 6 \times 10}{2 \times 2 \times 4} = \frac{3 \times 3 \times 5}{2 \times 2} = \frac{45}{4} = 11\frac{1}{4}$  acres.

CHAR. X. RULES OF PRACTICE.

When the first term of a question in the rule of three happens to be unity, the answer may frequently be found more speedily and easily than by a formal stating or working of the rule of three; and the directions to be observed in such operations are called *Rules of Practice*.

The rules of practice naturally follow the doctrine of vulgar fractions, the operation being nothing else but a multiplying the number whose price is required, by such a fraction of a pound, of a shilling, or of a penny, as denotes the rate or price of one.

Thus, if the price of 24 yards, at 6 s. 8 d. per yard, be demanded, the answer is found by multiplying 24 by  $\frac{1}{4}$ , the fraction of a pound equivalent to 6 s. 8 d. viz.  $\frac{1}{4} \times 24 = 6$  l.

Hence, it is obvious, that to multiply a number by a fraction whose numerator is unity, is to divide the said number by the denominator of the fraction. But if the numerator of the fraction be not unity, you must first multiply the given number by the numerator, and then divide the product by the denominator. Thus, if the rate be 13 s. 4 d. =  $\frac{1}{3}$  l. the price of 24 yards is found by saying,  $\frac{1}{3} \times 24 = 8$  l.; or take  $\frac{1}{3}$  of the given number twice.

When the fraction denoting the rate happens to be compound, the product or answer is found by dividing the given number by one of the denominators of the compound fraction, the quot by another, and the next quot by the third, &c. Thus, if the rate be 2 farthings =  $\frac{1}{4}$  of  $\frac{1}{2}$  of  $\frac{1}{20}$  l. the price of £440 yards is found by saying,  $\frac{440}{20} = 22$ , and  $\frac{22}{2} = 11$ , and  $\frac{11}{4} = 2$  l.

When the rate is expressed by two or more simple fractions, connected with the sign +, the product or answer is found by dividing the given number successively by the several denominators, and then adding the quot. Thus, if the rate be 3 s. =  $\frac{3}{20} + \frac{1}{20}$  l. the price of 80 yards is found by saying,  $\frac{80}{20} = 4$ , and  $\frac{4}{2} = 2$ , and  $4 + 2 = 6$  l.

The fractions equivalent to any number of farthings under 4, to any number of pence under 12, and to any number of shillings under 20, are exhibited in the following tables.

T A B L E I.

Farthings.	of a penny.	of a shilling.	of a pound.
1	$\frac{1}{4}$	$\frac{1}{2}$ of $\frac{1}{20}$	$\frac{1}{80}$ of $\frac{1}{20}$
2	$\frac{2}{4}$	$\frac{2}{20}$ of $\frac{1}{20}$	$\frac{1}{40}$ of $\frac{1}{20}$
3	$\frac{3}{4}$	$\frac{3}{20}$ of $\frac{1}{20}$	$\frac{3}{80}$ of $\frac{1}{20}$

T A B L E II.

Pen.	of a shill.
1	$\frac{1}{20}$
1½	$\frac{1}{16}$
2	$\frac{1}{10}$
3	$\frac{3}{20}$
4	$\frac{1}{5}$
5	$\frac{1}{4}$
6	$\frac{3}{10}$
7	$\frac{7}{20}$
8	$\frac{2}{5}$
9	$\frac{9}{20}$
10	$\frac{1}{2}$
11	$\frac{11}{20}$

T A B L E III.

s. d.	of a pound.	s. d.	of a pound.
1	$\frac{1}{20}$	9	$\frac{9}{20}$
1 8	$\frac{18}{20}$	10	$\frac{10}{20}$ or $\frac{1}{2}$
2	$\frac{2}{10}$	11	$\frac{11}{20}$
2 6	$\frac{26}{20}$	12	$\frac{12}{20}$ or $\frac{3}{5}$
3	$\frac{3}{10}$	13	$\frac{13}{20}$
3 4	$\frac{34}{20}$	13 4	$\frac{13}{20} + \frac{4}{20}$
4	$\frac{4}{10}$ or $\frac{2}{5}$	14	$\frac{14}{20}$
4 8	$\frac{48}{20}$ or $\frac{12}{5}$	15	$\frac{15}{20}$ or $\frac{3}{4}$
5	$\frac{5}{10}$ or $\frac{1}{2}$	16	$\frac{16}{20}$ or $\frac{4}{5}$
6	$\frac{6}{10}$	17	$\frac{17}{20}$
6 8	$\frac{68}{20}$	18	$\frac{18}{20}$
7	$\frac{7}{10}$	19	$\frac{19}{20}$
7 8	$\frac{78}{20}$ or $\frac{19}{5}$		

The fractions in Table II. become compound fractions of a pound, by annexing (of  $\frac{1}{20}$ ) to each of them. Thus, 1 d. is  $\frac{1}{20}$  of  $\frac{1}{20}$  l.; and 5 d. is  $\frac{1}{4}$  of  $\frac{1}{20}$  of  $\frac{1}{20}$  l. &c.

The variety that occurs in the rules of practice arises chiefly from the different rates, or prices, of one thing, as a yard, a pound, an ounce, &c. and may be reduced to the eight cases following, viz.

1. Pence under twelve.
2. Pence and farthings.
3. Shillings under twenty.
4. Shillings, pence, and farthings.
5. Shillings, pence, and farthings.
6. Pounds.
7. Pounds, shillings, pence, and farthings.
8. The given number may consist of integers and parts.

CASE I. When the rate is farthings, under four.

RULE. Divide the given number by the denominator of the fraction denoting the rate, as contained in Tab. II. viz. if the rate be 1 or 2 farthings, divide by 4 or 2, the quot will be pence; and the remainder, in dividing by 4, will be farthings, and in dividing by 2, it will be 1 halfpenny: then divide the pence by 12, the quot will be shillings, and the remainder pence. Lastly, divide the shillings by 20, the quot will be pounds, and the remainder shillings. But if the rate is 3 farthings, first multiply the given number by the numerator 3, and then divide as above directed.

Ex. 1.	Ex. 2.
$\frac{1}{4}$ 4859, at 1 f.	$\frac{1}{2}$ 8347, at 2 f.
$\frac{1}{2}$ 1214—3 f.	$\frac{1}{20}$ 4173—1 d.
$\frac{3}{20}$ 1011—2 d.	$\frac{3}{20}$ 347—9 d.
L. 5 1 2½	L. 17 7 9½

CASE II. When the rate is pence, under twelve.

RULE. Divide the given number by the denominator of the fraction denoting the rate, as contained in Table II. and you have the answer in shillings; which reduce into pounds, by dividing by 20.

$\frac{1}{12}$ 818, at 1 d. <hr/> $\frac{1}{20}$ 6 8—2 d. <hr/> L. 3 8 2	$\frac{1}{2}$ 5316, at 2 d. <hr/> $\frac{1}{20}$ 88 6 <hr/> L. 44 6
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Note, The remainders at the first division in the above examples are the same with the rate. Thus, in Ex. 1. every remainder is 1 d.

CASE III. When the rate is pence and farthings.

RULE. The pence must be some aliquot part of a shilling; and, at the same time, the farthings some aliquot part of the pence; and if they be not so given, divide the pence into two or more such parts, so as the farthings may be some aliquot part of the lowest division of the pence. Then, beginning with the highest division of the pence, divide by the denominators of the fractions denoting the aliquot parts.

$1\text{ d. } \frac{1}{12}$ 532, at $1\frac{1}{4}$ d. <hr/> $\frac{1}{4}\text{ d. } \frac{1}{4}$ 44—4 <hr/> $\frac{1}{20}$ 5 5—5 <hr/> L. 2 15 5	$1\text{ d. } \frac{1}{12}$ 1753, at $1\frac{1}{2}$ d. <hr/> $\frac{1}{2}\text{ d. } \frac{1}{2}$ 146—1 <hr/> $\frac{1}{20}$ 21 9—1 $\frac{1}{2}$ <hr/> L. 10 19 1 $\frac{1}{2}$
---	---

EXPLICATION.

In Ex. 1. work first for 1 d.; which being  $\frac{1}{12}$  s. divide the given number by the denominator 12, and the quot is shillings, and the remainder pence; then, because 1 farthing is  $\frac{1}{4}$  d. divide the former quot by 4, and the sum of the quots is the price in shillings; which divide by 20.

In Ex. 2. the rate  $1\frac{1}{2}$  d. being an aliquot part of a shilling, the second method is shorter and better than the first.

CASE IV. When the rate is shillings under twenty.

RULE. Multiply the given number by the numerator of the fractions contained in Tab. II. and divide the product by the denominators. Or, instead of this general rule, take the two particular ones following.

1. If the rate be an even number of shillings, multiply the given number by half the number of shillings in the rate, always doubling the right-hand figure of the product for shillings, and the rest are pounds.

2. If the rate be an odd number of shillings, work for the next lesser even number of shillings, as above; and for the odd shilling take  $\frac{1}{20}$  of the given number.

EXAMP. 1. When the rate is an even number of shillings.

$\frac{1}{20}$ 436, at 2 s. <hr/> L. 43 12 s.	$\frac{1}{20}$ 127, at 4 s. <hr/> L. 25 8 s.
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2. When the rate is an odd number of shillings.

$\frac{1}{20}$ 635, at 1 s. <hr/> L. 31 15 s.	$\frac{1}{20}$ 422, at 3 s. <hr/> 42 4 21 2 <hr/> L. 63 6 s.
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Note 1. The reason of multiplying by half the number of shillings in the rate will appear by considering, that these are the numerators of the fractions denoting the rate. Thus, 2 s. is  $\frac{1}{5}$  l. and 4 s. is  $\frac{1}{5}$  l. and 6 s. is  $\frac{3}{10}$  l. and each unit in the product is two shillings. The division by the denominator 10 is performed by cutting off the right-hand figure of the product, and the figure so cut off is the remainder; and as each unit in the remainder is two shillings, the double of them is the remainder in shillings.

Note 2. From Ex. 1. we may learn, that when the rate is 2 s. the price is found by doubling the right-hand figure of the given number for shillings, and the other figure or figures are pounds.

Note 3. In Ex. 2. the price may also be had by taking  $\frac{3}{10}$  of the given number; and in this way every remainder will be 4 s.

Note 4. By reverting the operation, from the price and any even rate given, we may readily find the quantity of goods, viz. Multiply the price by 10, that is, to the price annex a cipher, and divide the product by half the rate.

Ex. 1. How many yards, at 14 s., may be bought for 49 l. 7)490(70 yards. Ans.

Ex. 2. How many gallons, at 8 s., may be bought for 500 l. 4)5000(1250 gallons. Ans.

CASE V. When the rate is shillings and pence, or shillings, pence, and farthings.

RULE I. If the rate be shillings and pence which make an aliquot part of a pound, divide the given number by the denominator of the fraction denoting the rate; the quot is pounds, and each unit of the remainder is equal to the rate.

$\frac{1}{20}$ 354, at 1 s. 8 d. <hr/> L. 29 10 $\frac{1}{20}$ 443, at 2 s. 6 d. <hr/> L. 55 7 6
---

RULE II. If the rate be no aliquot part of a pound, but may be divided into such parts, divide it accordingly, work for the parts separately, and then add.

$\frac{1}{20}$ 427, at 8 s. <hr/> 6 s. 128 2 2 s. 6 d. 53 7 6 <hr/> L. 181 9 6	$\frac{1}{20}$ 540, at 5 s. <hr/> 4 d. 90 2 s. 54 <hr/> L. 144
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RULE III.

**RULE III.** If the rate be no aliquot part of a pound, and cannot readily be divided into such parts, divide it into parts whereof one at least may be an aliquot part of a pound, and the subsequent part, or parts, each an aliquot part of some prior part.

<p style="text-align: center;"><i>Ex. 1.</i></p> <p style="text-align: center;">350 6, at 1s. 3d.</p> <table style="margin-left: auto; margin-right: auto;"> <tr><td>1s. <math>\frac{1}{4}</math></td><td>175</td><td>6</td></tr> <tr><td>3d. <math>\frac{1}{4}</math></td><td>43</td><td>16 6</td></tr> <tr><td colspan="3" style="border-top: 1px solid black;"></td></tr> <tr><td colspan="3" style="text-align: center;">L. 219 2 6</td></tr> </table>	1s. $\frac{1}{4}$	175	6	3d. $\frac{1}{4}$	43	16 6				L. 219 2 6			<p style="text-align: center;"><i>Ex. 2.</i></p> <p style="text-align: center;">9 5, at 1s. 10<math>\frac{1}{2}</math>d.</p> <table style="margin-left: auto; margin-right: auto;"> <tr><td>1s. <math>\frac{1}{2}</math></td><td>4</td><td>15</td></tr> <tr><td>6d. <math>\frac{1}{4}</math></td><td>2</td><td>7 6</td></tr> <tr><td>3d. <math>\frac{1}{2}</math></td><td>1</td><td>3 9</td></tr> <tr><td>1<math>\frac{1}{2}</math>d. <math>\frac{1}{2}</math></td><td>11</td><td>10<math>\frac{1}{2}</math></td></tr> <tr><td colspan="3" style="border-top: 1px solid black;"></td></tr> <tr><td colspan="3" style="text-align: center;">L. 8 18 1<math>\frac{1}{2}</math></td></tr> </table>	1s. $\frac{1}{2}$	4	15	6d. $\frac{1}{4}$	2	7 6	3d. $\frac{1}{2}$	1	3 9	1 $\frac{1}{2}$ d. $\frac{1}{2}$	11	10 $\frac{1}{2}$				L. 8 18 1 $\frac{1}{2}$		
1s. $\frac{1}{4}$	175	6																													
3d. $\frac{1}{4}$	43	16 6																													
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1s. $\frac{1}{2}$	4	15																													
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3d. $\frac{1}{2}$	1	3 9																													
1 $\frac{1}{2}$ d. $\frac{1}{2}$	11	10 $\frac{1}{2}$																													
L. 8 18 1 $\frac{1}{2}$																															

**CASE VI.** When the rate is pounds.

**RULE.** Multiply the given number by the rate, and the product is the price in pounds.

<i>Ex. 1.</i> 42, at 2l.	<i>Ex. 2.</i> 13, at 8l.
L. 84	L. 104

**CASE VII.** When the rate is pounds and shillings, or pounds, shillings, pence, and farthings.

**RULE I.** If the rate be pounds and shillings, multiply the given number by the pounds, and work for the shillings as in Case IV.

<p style="text-align: center;"><i>Ex. 1.</i></p> <p style="text-align: center;">46, at 1l. 4s.</p> <table style="margin-left: auto; margin-right: auto;"> <tr><td>1l.</td><td>46</td></tr> <tr><td>4s.</td><td>9 4</td></tr> <tr><td colspan="2" style="border-top: 1px solid black;"></td></tr> <tr><td colspan="2" style="text-align: center;">L. 55 4</td></tr> </table>	1l.	46	4s.	9 4			L. 55 4		<p style="text-align: center;"><i>Ex. 2.</i></p> <p style="text-align: center;">82, at 4l. 10s.</p> <table style="margin-left: auto; margin-right: auto;"> <tr><td>4l.</td><td>328</td></tr> <tr><td>10s.</td><td>41</td></tr> <tr><td colspan="2" style="border-top: 1px solid black;"></td></tr> <tr><td colspan="2" style="text-align: center;">L. 369</td></tr> </table>	4l.	328	10s.	41			L. 369	
1l.	46																
4s.	9 4																
L. 55 4																	
4l.	328																
10s.	41																
L. 369																	

*Note.* When the rate is more than 1l. and less than 2l. as in Ex. 1. we have no occasion to draw a line under the given number, it being esteemed so many pounds, and the parts for the shillings or pence are added up with it.

**RULE II.** If the rate be pounds, with shillings and pence that make some aliquot part of a pound, or are divisible into aliquot parts, or into shillings and some aliquot part or parts; then multiply the given number by the pounds; and work for the shillings and pence as in Case V. Rule I or II.

<p style="text-align: center;"><i>Ex. 1.</i></p> <p style="text-align: center;">54, at L. 3:2:6.</p> <table style="margin-left: auto; margin-right: auto;"> <tr><td>3l.</td><td>162</td></tr> <tr><td>2s. 6d.</td><td>6 15</td></tr> <tr><td colspan="2" style="border-top: 1px solid black;"></td></tr> <tr><td colspan="2" style="text-align: center;">L. 168 15</td></tr> </table>	3l.	162	2s. 6d.	6 15			L. 168 15		<p style="text-align: center;"><i>Ex. 2.</i></p> <p style="text-align: center;">43, at L. 5:3:4.</p> <table style="margin-left: auto; margin-right: auto;"> <tr><td>5l.</td><td>215</td></tr> <tr><td>3s. 4d.</td><td>7 3 4</td></tr> <tr><td colspan="2" style="border-top: 1px solid black;"></td></tr> <tr><td colspan="2" style="text-align: center;">L. 222 3 4</td></tr> </table>	5l.	215	3s. 4d.	7 3 4			L. 222 3 4	
3l.	162																
2s. 6d.	6 15																
L. 168 15																	
5l.	215																
3s. 4d.	7 3 4																
L. 222 3 4																	

**RULE III.** If the rate be pounds, with shillings, pence, and farthings, that cannot readily be resolved into aliquot parts of a pound; multiply the given number by the pounds; and then work for the shillings, pence, and farthings, as in Case V. Rule III.

*Ex. 1.*

1l.	213, at 1l. 13s. 4 $\frac{1}{2}$ d.
10s.	106 10
2s.	21 6
1s.	10 13
3d.	2 13 3
1 $\frac{1}{2}$ d.	1 6 7 $\frac{1}{2}$
L. 355 8 10 $\frac{1}{2}$	

*Ex. 2.*

37, at 3l. 8s. 10 $\frac{1}{2}$ d.	
3l.	111
6s.	11 2
2s. 6d.	4 12 6
3d.	9 3
1d.	3 1
$\frac{1}{2}$ d.	9 $\frac{1}{2}$
L. 127 7 7 $\frac{1}{2}$	

**CASE VIII.** When the given number consists of integers and parts.

**RULE.** Work for the price of the integers as already taught; and for the part or parts, take a proportional part or parts of the rate.

<p style="text-align: center;"><i>Ex. 1.</i></p> <p style="text-align: center;">Yards. 720<math>\frac{1}{2}</math>, at 6s. 8d. per yd.</p> <table style="margin-left: auto; margin-right: auto;"> <tr><td>6s. 8d.</td><td>240</td></tr> <tr><td><math>\frac{1}{2}</math> yd.</td><td>0 1 8</td></tr> <tr><td colspan="2" style="border-top: 1px solid black;"></td></tr> <tr><td colspan="2" style="text-align: center;">L. 240 1 8</td></tr> </table>	6s. 8d.	240	$\frac{1}{2}$ yd.	0 1 8			L. 240 1 8		<p style="text-align: center;"><i>Ex. 2.</i></p> <p style="text-align: center;">Yards. 116<math>\frac{1}{2}</math>, at 4s. 6d. per yd.</p> <table style="margin-left: auto; margin-right: auto;"> <tr><td>2s. 6d.</td><td>14 10</td></tr> <tr><td>2s.</td><td>11 12</td></tr> <tr><td><math>\frac{1}{2}</math> yd.</td><td>2 3</td></tr> <tr><td colspan="2" style="border-top: 1px solid black;"></td></tr> <tr><td colspan="2" style="text-align: center;">L. 26 4 3</td></tr> </table>	2s. 6d.	14 10	2s.	11 12	$\frac{1}{2}$ yd.	2 3			L. 26 4 3	
6s. 8d.	240																		
$\frac{1}{2}$ yd.	0 1 8																		
L. 240 1 8																			
2s. 6d.	14 10																		
2s.	11 12																		
$\frac{1}{2}$ yd.	2 3																		
L. 26 4 3																			

An operation in the rules of practice may be proved by running over the several steps a second time, by working the same question a different way, or by the rule of three.

## CHAP. XI. OF DECIMALS.

### I. Notation.

A FRACTION having 10, 100, 1000, or unity with any number of ciphers annexed to it, for a denominator, is called a *decimal fraction*; such as,  $\frac{1}{10}$ ,  $\frac{2}{100}$ ,  $\frac{14}{1000}$ ,  $\frac{100}{10000}$ .

In decimal fractions, as in vulgar, the denominator shews into how many parts the unit or integer is divided, and the numerator shews how many of these parts the fraction contains. Thus, if the fraction be  $\frac{9}{10}$ , the unit is divided into ten equal parts, and the fraction contains nine of these parts; and consequently, if the unit or integer be a pound Sterling, the value of such a fraction is eighteen shillings.

We may conceive the denominator of a decimal fraction to be formed by dividing the unit into 10 equal parts, and each of these parts into 10 other equal parts; each of these again into 10 other equal parts, and so on, as far as necessary; and hence a decimal fraction will always be so many tenths, or so many tenths of  $\frac{1}{10}$ , or so many tenths of  $\frac{1}{10}$  of  $\frac{1}{10}$ , &c.; and by reducing the compound fraction to a simple one, we have the decimal. Thus,  $\frac{1}{10}$  of  $\frac{1}{10}$  of  $\frac{1}{10}$  =  $\frac{1}{1000}$ .

Or

Or we may conceive the denominator of a decimal to be formed by the continual multiplication of unity into 10, as often as there are ciphers in it. Thus,  $1 \times 10 = 10$ , and  $1 \times 10 \times 10 = 100$ , and  $1 \times 10 \times 10 \times 10 = 1000$ , &c. And because the fractions  $\frac{1}{10}$ ,  $\frac{1}{100}$ ,  $\frac{1}{1000}$ , &c. have the highest numerators possible; it is plain, that the number of figures or places in the numerator of a decimal can never exceed the number of ciphers in the denominator.

It is usual to write down only the numerator of a decimal fraction, omitting the denominator; and when the numerator has the same number of figures or places as the denominator has ciphers, it is done by writing down the figures of the numerator, and prefixing a point, to distinguish them from a whole number. So  $\frac{7}{10}$  is written thus, .7; and  $\frac{25}{100}$  is written thus, .25. The point thus prefixed is called the *decimal point*.

But when the numerator has not so many figures or places as there are ciphers in the denominator, the defect is supplied by prefixing a cipher for every figure wanting, and then placing the decimal point on the left. So  $\frac{3}{100}$  is written thus, .03; and  $\frac{75}{10000}$  thus, .0075; and  $\frac{5}{100000}$  thus, .0005.

From this manner of notation, it is easy to read a decimal, or to know its denominator, *viz.* imagine 1 to stand under the decimal point, and a cipher under every decimal place. Thus, .9 is  $\frac{9}{10}$ , and .48 is  $\frac{48}{100}$ , and .05 is  $\frac{5}{100}$ , and .007 is  $\frac{7}{1000}$ , and .00036 is  $\frac{36}{100000}$ .

Hence it is plain, that decimals, like integers, decrease from the left to the right, and increase from the right to the left, in a decuple proportion. On the contrary, any decimal figure, by being removed one place toward the left, becomes ten times greater.

An integer, by annexing ciphers, is raised to higher places on the left, and may by this means have its value increased to infinity. On the other hand, a decimal, by prefixing ciphers, is depressed to lower places on the right, and may by this means have its value diminished to infinity.

Ciphers annexed to decimals do not change the value of the decimals. Thus,  $.50 = .5$ , and  $.500 = .5$ , for  $.50 = \frac{50}{100} = \frac{5}{10} = .5$ ; and  $\frac{500}{1000} = \frac{5}{10} = .5$ .

Decimals may be resolved into constituent parts, and the parts may be read, separately, thus,  $.847 = 8 \text{ } \frac{4}{10} + .07 = \frac{8}{10} + \frac{4}{100} + \frac{7}{1000}$ .

In decimals the figure next the point, being the first decimal place, is sometimes called *primes*, and the second figure from the point is called *seconds*, the next *thirds*, &c. Thus, in .875 the figure 8 is primes, 7 is seconds, and 5 is thirds.

From this brief account of the nature of decimals, it follows, that the manner of operation in decimals will be the same as in whole numbers; and also, that the same number may be differently expressed, according as the integer is chosen. Thus, the time since our Saviour's birth may be written thus, 1769; or thus, 176.9; or thus, 17.69; or thus, 1.769; or thus, .1769, according as one year, a decad, a century, a chiliad, or myriad, is used as the integer. Hence arises the superior excellency of decimal arithmetic, above every

other sort of numerical computation; as will appear in the sequel.

## II. Reduction of Decimals.

PROB. I. To reduce a vulgar fraction to a decimal.

RULE. To the numerator of the vulgar fraction affix a point or comma, then annex a competent number of ciphers, and divide by the denominator; the quot is the numerator of the decimal, and the cyphers annexed show the number of decimal places.

EXAMP. I. Reduce  $\frac{1}{2}$  to a decimal?

Here to the numerator 1 annex one cipher, 2)1.0(.5 and dividing by the denominator 2, the quot is .5, and 0 remains; and because a single cipher only was annexed to the numerator, the decimal numerator will consist but of one figure, namely 5; to which, therefore, prefix the decimal point. So  $\frac{1}{2} = .5$ .

Hence appears the reason of the rule; namely,  $2 : 1 :: 10 : 5$ ; that is, as the vulgar denominator to the vulgar numerator, so is the decimal denominator to the decimal numerator.

EXAMP. II. Reduce  $\frac{3}{4}$  to a decimal.

To the numerator 3, annex two ciphers; and, dividing by the denominator, the quot gives 75 for the numerator of the decimal, two ciphers having been annexed. So  $\frac{3}{4} = .75$ .

$$\begin{array}{r} 4 \overline{) 3.00(.75} \\ \underline{28} \phantom{0} \\ 20 \phantom{0} \\ \underline{20} \\ 0 \end{array}$$

Though ciphers may be annexed at pleasure, yet it is the ciphers used that determine the number of decimal places in the quot; and at first it is sufficient to annex so many as serve to complete the first dividend, leaving room to annex more as you proceed in the operation; or rather annex the other ciphers to the remainders, without giving them a place in the dividend.

The first dividend, also, shows whether ciphers ought to be prefixed to the quot, and how many. Thus, if the first dividend take an only one of the annexed ciphers, the figure put in the quot is primes, and no cipher to be prefixed. If the first dividend comprehend two of the annexed ciphers, the figure put in the quot is seconds, and one cipher must be prefixed. If the first dividend comprehend three of the annexed ciphers, the figure put in the quot is thirds, and two ciphers must be prefixed, &c. Hence, in reducing a vulgar fraction to a decimal, the natural and easy way is, to place first the decimal point in the quot, and after it a cipher or ciphers, or the quotient-figure, as the first dividend directs.

In reducing a vulgar fraction to a decimal, if 0 at last remains, as in all the above examples, the decimal is precisely equal to the vulgar fraction, and is called a *finite or terminate decimal*.

In finite decimals, the denominator is always some aliquot part of the numerator increased by annexing ciphers; and such decimals take their rise from vulgar fractions whose denominator is 2 or 5, or some power of

2 or 5, or the product of some of their powers. See Chap. XII. and ALGEBRA, Chap. III.

The powers of numbers are sometimes expressed by indices or exponents placed at the corners of the numbers. Thus, 2<sup>2</sup> signifies the second power of 2, and 5<sup>3</sup> signifies the third power of 5; and 10<sup>4</sup> signifies the fourth power of 10, &c. The index of the root or first power is seldom expressed.

Any power of 2 multiplied into the like power of 5 gives a product equal to the same power of 10; as appears from the following specimen of the powers of 2, 5, and 10.

2 <sup>1</sup> = 2	5 <sup>1</sup> = 5	2 × 5 = 10 <sup>1</sup> = 10
2 <sup>2</sup> = 4	5 <sup>2</sup> = 25	4 × 25 = 10 <sup>2</sup> = 100
2 <sup>3</sup> = 8	5 <sup>3</sup> = 125	8 × 125 = 10 <sup>3</sup> = 1000
2 <sup>4</sup> = 16	5 <sup>4</sup> = 625	16 × 625 = 10 <sup>4</sup> = 10000
2 <sup>5</sup> = 32	5 <sup>5</sup> = 3125	32 × 3125 = 10 <sup>5</sup> = 100000
2 <sup>6</sup> = 64	5 <sup>6</sup> = 15625	64 × 15625 = 10 <sup>6</sup> = 1000000
2 <sup>7</sup> = 128	5 <sup>7</sup> = 78125	128 × 78125 = 10 <sup>7</sup> = 10000000
∴	∴	∴

The product of two different powers of 2 and 5, is equal to the product that will arise by raising 10 to the power denoted by the lesser given index, and then multiplying this power of 10 into that power of the other number which is denoted by the difference of the two given exponents. Thus,

$$2^6 \times 5^2 = 64 \times 25 = 10^3 \times 2^1 = 100 \times 16 = 1600$$

$$2^2 \times 5^6 = 4 \times 15625 = 10^2 \times 5^4 = 100 \times 625 = 62500$$

From these remarks it is easy to perceive, that 2 or 5, or any of their powers, or product of their powers, will measure 10 or its powers, viz. 100, 1000, &c. or their multiples, such as, 20, 200, 2000, &c. 30, 300, 3000, &c.; and such every numerator becomes by having ciphers annexed; and therefore 2 or 5, or their powers, or product of their powers, used as a denominator, will divide any numerator with a competent number of ciphers annexed, and leave no remainder; and consequently the decimal thence resulting will be finite.

If the numerator of the vulgar fraction be unity, and the denominator any single power of 2 or 5, there will be as many decimal places in the quot as there are units in the index of the given power. Thus, 16 = 2<sup>4</sup> gives a decimal of four places, viz.  $\frac{1}{16} = .0625$ ; and, 125 = 5<sup>3</sup> gives a decimal of three places, viz.  $\frac{1}{125} = .008$ .

When the denominator is the product of like powers of 2 and 5; in this case, such a product being equal to the like power of 10, and any power of 10 being equal to 1, with as many ciphers annexed as there are units in the index, it follows, that there will still be as many decimal places in the quot as there are units in the index, either of 2, of 5, or 10. Thus, 8 × 125 = 2<sup>3</sup> × 5<sup>3</sup> = 10<sup>3</sup> = 1000, gives a decimal of three places, viz.  $\frac{1}{1000} = .001$ .

When the denominator is the product of different powers of 2 or 5, find what power of 10, and what power of 2 or 5, upon being multiplied, will give the same product, as is taught above; and the sum of the indices shews the number of decimal places; thus,

2<sup>6</sup> × 5<sup>3</sup> = 10<sup>3</sup> × 2<sup>3</sup>; and the sum of the indices, 2 + 4 = 6, gives the number of decimal places, viz.  $\frac{1}{1000} = .000625$ .

And, in general, to find what number of decimal places any such vulgar fraction will give, divide the denominator by 2, 5, or 10, till the last quotient be 1, and the remainder 0; and the number of divisors shews the number of decimal places. Thus,  $\frac{1}{16}$  gives a deci-

mal of four places; for 2)16(8(4(2(1. And  $\frac{1}{125}$  gives

a decimal of three places; for 5)125(25(5(1. And  $\frac{1}{1000}$  gives a decimal of three places; for 10)1000

(100)10(1. And  $\frac{1}{10000}$  gives a decimal of six places;

for 10)10000(1000(10(10(10(10(10(1. And  $\frac{1}{1000000}$  gives a decimal of six places;

If the denominator of a vulgar fraction be neither 2 nor 5, nor any of their powers, nor product of their powers, such a denominator will not divide the numerator with annexed ciphers without a remainder; and the decimal thence resulting is called *infinite*, or *interminate*.

Of infinite or interminate decimals, there are two sorts. For some constantly repeat the same figure; and are called *repeating decimals*, *repeaters*, or *single repetends*. Others repeat a circle of figures; and on that account are called *circulating decimals*, *circulates*, or *compound repetends*.

EXAMP. III. Reduce  $\frac{1}{3}$  to a decimal.

Here the remainder being still the same, 3)1.0(.3  
9  
—  
(1)  
viz. 1, the same figure will constantly be repeated in the quot.

Repeating decimals are of two kinds: viz. some consist only of the repeating figures, such as the examples above; and these are called *pure repeaters*; others have one or more digits or ciphers betwixt the decimal point and the repeating figure; and these are called *mixt repeaters*; and the digits or ciphers on the left of the repeating figures are called the *finite part* of such decimals.

Pure repeaters take their rise from vulgar fractions whose denominator is 3, or its multiple 9; and are but few in number.

Mixt repeaters derive their origin from vulgar fractions whose denominator is the product of 3 into 2 or 5, or into some of their powers, or product of their powers; and such denominators may be considered as the product of two component parts, whereof one is 2 or 5, or some of their powers, or product of their powers; and hence the finite part. The other component part is 3; and hence the repeating figure.

EXAMP. IV. Reduce  $\frac{1}{6}$  to a decimal.

Here the repeater is mixt, the finite part 15)4.0(.26  
30  
—  
\*100  
90  
—  
(10)  
being 2, and the repeating figure 6.

We now resolve such denominators into their component parts, and divide the numerator by one of these parts, and then divide the quot by the other. Thus,  $15 = 5 \times 3$ .

$$\begin{array}{r} 5)4.0(8 \\ \underline{40} \\ (0) \end{array} \quad \text{and} \quad \begin{array}{r} 3)8.(26 \\ \underline{6} \\ *20 \\ \underline{18} \\ (2) \end{array}$$

The number of places in the finite part of a mixt repeater may be ascertained from the number of units in the index of the powers of 2 or 5.

And, universally, to find the number of places in the finite part of such fractions, divide the denominator first by 3, and then divide the quot by 2, 5, or 10, till the last quot be 1, and 0 remain; and the number of divisors, excluding 3, shows the number of places in the finite part.

Repeating decimals are usually marked by a dash through the right-hand figure, as in the examples above: But some chuse to mark them by a point set over the repeating figure, thus,  $\dot{3}$ ,  $\dot{26}$ . The remainder where the repetition begins is commonly marked with an asterisk.

Because any quotient multiplied by the divisor reproduces the dividend, it follows, that any decimal multiplied by the denominator of the vulgar fraction from which it resulted, will reproduce the numerator with the annexed ciphers. Thus, if  $.75$ , the decimal of  $\frac{3}{4}$ , be multiplied by 4, it will reproduce the numerator 3 and the two annexed ciphers.

Now, suppose the given decimal to be a repeater; such as  $\dot{3}$ , resulting from the vulgar fraction  $\frac{1}{3}$ , if the repeating decimal be multiplied by the denominator 3, it will, by carrying at 9 on the right hand, reproduce the numerator 1 with the annexed cipher. In like manner, if the repeater  $\dot{6} = \frac{2}{3}$ , be multiplied by 3, it will, by carrying at 9 on the right hand, reproduce the numerator 2 with the annexed cipher. Again, if the repeater  $\dot{4} = \frac{4}{9}$ , be multiplied by the denominator 9, it will, by carrying at 9 on the right hand, reproduce the numerator 1 with the annexed cipher. And, if the mixt repeater  $\dot{26} = \frac{4}{15}$ , be multiplied by the denominator 15, it will, by carrying at 9 on the right hand, reproduce the numerator 4 with the two annexed ciphers.

From these remarks we may conclude, that the right-hand figure of every repeating decimal is ninth-parts: and the same truth may be evinced by resolving the decimal into its constituent parts, in the following manner.

The vulgar fraction  $\frac{1}{3}$  reduced to a decimal gives  $\dot{3}$ , &c.; and this repeater resolved into decimal constituent parts, becomes  $\frac{1}{10} + \frac{1}{100} + \frac{1}{1000}$ , &c. to infinity. But if we esteem the right-hand figure to be ninth-parts, we have  $\frac{1}{10} + \frac{1}{9} \text{ of } \frac{1}{10} = \frac{1}{10} + \frac{1}{90} = \frac{10}{90} + \frac{1}{90} = \frac{11}{90} = \frac{1}{8\frac{1}{9}}$ , the given vulgar fraction. And as the vulgar fraction  $\frac{1}{3}$  gives  $\dot{3}$ , so  $\frac{2}{3}$  gives  $\dot{6}$ ; that is,  $\dot{6} = \frac{2}{3} = 1$ . And, universally, a series of nines infinitely continued is equal to unity in the place on the left hand; thus,  $\dot{999} =$

1; and  $\dot{9999} = .1$ ; and  $\dot{99999} = .01$ . and  $44.\dot{9}9 = 45$ . Hence may be ascertained the value of an infinite series decreasing in a decuple proportion. Thus,  $\frac{1}{10} + \frac{1}{100} + \frac{1}{1000}$ , &c.  $= \frac{1}{9}$ . And  $\frac{1}{10} + \frac{1}{100} + \frac{1}{1000}$ , &c.  $= \frac{1}{9}$ .

If the denominator of a vulgar fraction be neither 2 nor 5, nor any power of 2 or 5, nor any product of their powers; nor 3, nor 9, nor any product of 3 into 2 or 5, or into some of their powers, or product of their powers, the decimal resulting from such a vulgar fraction will circulate.

Circulates, like repeaters, are of two sorts, viz. pure and mixt. A pure circulate consists of the figures of the circle only; as  $.09, 09$ , &c. or  $18, 18$ , &c. A mixt circulate has a finite part betwixt the decimal point and the figure that begins the circle; as  $.0, 45, 45$ , &c.; or  $.32, 142857, 142857$ , &c. Some chuse to distinguish the finite part from the circle, and one circle from another, by a comma, as above. Others dash the first and last figure of the circle. It is likewise usual to mark the remainder where the new circle begins, by affixing an asterisk.

EXAMP. V. Reduce  $\frac{1}{11}$  to a decimal.

The denominator 11 gives a pure 11)1.00(.09.09, circle of two figures.

$$\begin{array}{r} 99 \\ \underline{100} \\ *100 \\ \underline{99} \\ *1 \end{array}$$

$\frac{1}{11} = .18, 18,$	$\frac{7}{11} = .63, 63,$
$\frac{2}{11} = .27, 27,$	$\frac{8}{11} = .72, 72,$
$\frac{3}{11} = .36, 36,$	$\frac{9}{11} = .81, 81,$
$\frac{4}{11} = .45, 45,$	$\frac{10}{11} = .90, 90,$
$\frac{5}{11} = .54, 54,$	

It is easy to perceive, that if any of the vulgar fractions in the above specimen have both its numerator and denominator multiplied by 9, there will arise a new vulgar fraction of the same value, whose numerator will be the figures of the circle, and its denominator the like number of 9's. Thus,

$$\frac{3 \times 9}{11 \times 9} = \frac{27}{99}, \text{ and } \frac{7 \times 9}{11 \times 9} = \frac{63}{99}.$$

As the denominator 11, whereof 99 is a multiple, gives a pure circulate of two places; so any denominator, whereof 999, or 9999, or 99999, &c. are multiples, will give a pure circulate of three, four, five, &c. places; that is, of as many places as there are 9's in the multiple. And such denominators are all the prime numbers, except 2, 3, and 5, viz. 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, &c.; also their products into 3, viz. 21, 33, 39, 51, 57, 69, &c. Such too are all the powers of 3, except 3 and 9, viz. 27, 81, 243, 729, 2187, &c.

The reason is plain: for if any divisor, as 37, divide 999, without a remainder, it will also divide 1000, and leave a remainder of 1, to begin a new circle.

To find how many places the circle will consist of, divide a competent number of 9's by any of the above denominators, continuing the operation till 0 remain; and the number of 9's used will show the number of places.

Thus,



Thus, 7)999999 six places. Thus, 27)999 three places.

The number of figures in a circle, when some power of 3 is the denominator, may also be found thus: Divide the given denominator by 9, and the number of units in the quot will be equal to the number of figures in the circle. Thus, 9)27(3 places. Thus, 9)81(9 places, &c.

If 3 divide a repeater whose repeating figure is not a multiple of 3, the quot will be a pure circulate of three places. Thus, 3).711(.037, and 3).855(.185, and 3).777(.259).

If 3 divide a pure circulate, the circle not being a multiple of 3, the quot will be a pure circulate of thrice as many places as the circle of the dividend. Thus, 3).037.037.037( 012345679.

Mixt circulates take their rise from fractions whose denominators are the prime numbers 7, 11, 13, 17, 19, 23, 29, &c. multiplied into 2, 5, or 10, or into some of their powers, or product of their powers.

EXAMP. VI. Reduce  $\frac{1}{8}$  to a decimal.

28)9.0(.32, 142857, 14

```

  8 4
  ---
    60
    56
  ---
   * 40
    28
  ---
    120
    112
  ---
     80
     56
  ---
    240
    224
  ---
    160
    140
  ---
    200
    196
  ---
   * 40
    28
  ---
    120
    112
  ---
     8
  
```

The denominator 28 = 7 x 2 x 2, gives a mixt circulate, consisting of the finite part 32, and a circle of six figures or places, whose sum is equal to the product of 9 into half the number of figures; that is, 9 x 3 = 27.

The number of places, both in the finite part and in the circle, may be ascertained thus; Divide the denominator of the vulgar fraction by 10, 5, or 2, as often as possible, and the number of divisors will show the number of places in the finite part; make the last quot a divisor, and the dividend any competent number of 9's; continue the operation till 0 remain, and the number of 9's used will be equal to the number of places in the

circle. Thus, 10)20500(2050(205(41; and 41)99999(2439, and c remains. So you may conclude, that the finite part will consist of three places, and the circle of five.

Universally, any vulgar fraction being given, we may determine whether the decimal thence resulting will be finite or infinite; and if infinite, whether pure or mixt; with the number of places, &c. in the following manner.

Reduce the given vulgar fraction to its lowest terms, then divide the denominator by 10, 5, or 2, as often as possible; and if the last quot be unity, without any remainder, the decimal is finite, and the number of divisors shews the number of decimal places.

If the last quot be 3, or any power of 3, the resulting decimal will be a mixt repeater; the number of whose finite places will be equal to the number of divisors.

If the last quot cannot be divided by 2, 5, 10, or 3, the resulting decimal will be a mixt circulate; and the way of finding the number of places, both in the finite part and circle, is taught above.

If the denominator of the given vulgar fraction can be divided, neither by 2, 5, nor 10, the resulting decimal will be a pure repeater, or a pure circulate, according as the denominator is 3 or 9, or some of the prime numbers, 7, 11, 13, &c.; as has been already explained.

Every vulgar fraction may be reduced to a decimal, finite or infinite; that is, to a finite decimal, to a repeater, or a circulate. For if the denominator divide the numerator with ciphers annexed, so as to leave no remainder, the resulting decimal is finite. If the remaining figure be always the same, the resulting decimal will be a repeater. If neither of these be the case, yet, because the divisor is a finite number, the remainder at last must either be the same with the numerator of the vulgar fraction, or the same with some preceding remainder, and then a new circle begins; and consequently the resulting decimal will be a circulate.

Because in circulates the circle runs on sometimes to 16, 18, 22, 28, 81, 243, &c. places, and because, in decimals of every sort, the finite part runs sometimes on to many places, such circulates, or finite parts, may, without any sensible error, be limited at five or six places, and used as finites: for five decimal places, divide the integer into 100,000 equal parts, and all the loss that can be occasioned by such limitation, is less than one hundred thousandth part of the integer. And in most cases, the decimal may be limited at three places, which divide the integer into 1000 equal parts.

Circulates, or finite parts, thus limited, are called *approximate decimals*; and are sometimes marked with + or - annexed, according as the right-hand figure is taken less or greater than just: for in limiting the decimal, if you foresee that the succeeding figure of the quot would be 6 or 7, or any figure above 5, you lessen the error by increasing the right-hand figure of the approximate by unity.

PROB. II. To reduce the parts of coin, &c. to decimals.

RULE. Convert the given part or parts to a vulgar fraction.

fraction of the integer, and then reduce the vulgar fraction to a decimal.

Ex. 1. Reduce 9 pence to the decimal of a shilling.  
*d. s.*  
 $9 = \frac{9}{12}$  and  $12)9.0(.75$  of a shilling.

Here the fraction  $\frac{9}{12} = \frac{3}{4}$ ; and  $\frac{3}{4}$   
 the denominator  $4 = 2 \times 2$  gives 60  
 a finite decimal of two places. 60  
 —  
 (0)

Ex. 2. Reduce 9 pence to the decimal of a pound.  
*d. L.*  
 $9 = \frac{9}{20}$   $240)9.00(.0375$  of a pound.

The fraction  $\frac{9}{20} = \frac{9 \times 5}{20 \times 5} = \frac{45}{100}$ ;  
 and the denominator  $100 = 10 \times 10$  gives a finite  
 decimal of four places.  
 $100 \overline{)45.00}$   
 1200  
 1200  
 —  
 (0)

Ex. 3. Reduce 16 s. 6 d. to the decimal of a pound.

*s. d. L.*  
 $16 \text{ s. } 6 \text{ d.} = \frac{16 \times 20 + 6}{20}$   
 $12 \overline{)198}$   $240)198.0(.825 \text{ L.}$   
 192 0  
 6 00  
 4 80  
 —  
 1 200  
 1 200  
 —  
 (0)

The fraction  $\frac{16 \times 20 + 6}{20} = \frac{326}{20} = \frac{163}{10}$ ;  
 and the denominator  $10 = 10 \times 1$   
 $\times 2$  gives a finite decimal of three  
 places.

PROB. III. To reduce the remainder of a division to a decimal.

RULE. The remainder being the numerator, and the divisor the denominator of a vulgar fraction, after placing the decimal point on the right of the integral part of the quot, annex ciphers to the remainder; then continue the division till 0 remain, or till the quot repeat or circulate, or till you think proper to limit the decimal; and the number on the right of the point is a decimal of the integer expressed in the quot.

Example 1.  
 Divide 513 l. among 36 men.

*L.*  
 $36)513(14.25$   
 36  
 —  
 153  
 144  
 —  
 Rem. 90  
 72  
 —  
 180  
 180  
 —  
 (0)

Example 2.  
 Divide 176 s. among 24 boys.

*s.*  
 $24)176(7.3$   
 168  
 —  
 Rem. 80  
 72  
 —  
 (8)

PROB. IV. To reduce a decimal to value.

RULE. Multiply the given decimal by the number of parts of the next inferior denomination contained in an unit of the integer; and from the product point off so many figures to the right hand as there are places in the given decimal. On the left hand of the point are parts, and on the right a decimal of one of these parts; which decimal must be reduced in the same manner to the next inferior denomination, and from that to the next, and so on to the lowest; the several figures on the left of the points are parts; and if there be still some figure or figures on the right, they are a decimal of the lowest of the parts.

Example 1.  
 Reduce .875 l. to value.  
*L. s. d.*  
 $.875 = 17 \text{ s. } 6 \text{ d.}$   
 20  
 —  
*s.* 17.500  
 12  
 —  
*d.* 6.0

Example 2.  
 Reduce .7691 l. to value.  
*L. s. d. f.*  
 $.7691 = 15 \text{ s. } 4 \text{ d. } 2 \text{ f.}$   
 20  
 —  
*s.* 15.3820  
 12  
 —  
*d.* 4.584  
 4  
 —  
*f.* 2.336

The reason of pointing the product, as the rule directs, is plain. For, in Ex. 1. as  $1000 : 875 :: 20 : 17$ ; that is, as the decimal denominator to the decimal numerator, so the vulgar denominator to the vulgar numerator.

In Ex. 1. the full value of the decimal comes out in parts, the decimal being quite exhausted; but in Ex. 2. besides the parts, there is a decimal of a farthing, viz. .336 f.

The decimal of a pound Sterling may be reduced to value by inspection, in the following manner.

Double the figure in the place of primes for shillings; and if the figure in the place of seconds be 5, or exceed 5, reckon 1 shilling more; and rejecting 5 in the second place, the figures in the second and third places are so many farthings, abating 1 for every 25.

*L. s. d. f.*  
 EXAMP. 1. .718 = 14 4 2  
 2. .759 = 15 2 1  
 3. .894 = 17 10 3

In Example 1. the figure 7 doubled gives 14 s.; the two following figures 18 are farthings, equal to 4 d. 2 f.

In Example 2. the figure 7 doubled gives 14 s. and 5 in the place of seconds gives 1 shilling more, in all 15 s.; and the other figure 9 is farthings, viz. 2 d 1 f.

In Example 3. the figure 8 in the place of primes, and 5 in the place of seconds, give 17 s.; the remaining figures 94, are farthings, viz. 10 d. 3 f.

When the figures in the second and third place to be converted into farthings are 25, the answer, by inspection, comes out exact, viz. 24 f. or 6 d.; but in all other cases, the answer, by inspection, is too great, no allowance or correction being made till the convertible number

number amount to 25, and afford a deduction of 1 farthing complete. Hence, by inspection, we have frequently 1 farthing more than by the common method; but the two methods will agree, or give the same answer, if, from the figures to be turned into farthings, we subtract their 25th part, esteeming the remainder farthings and decimal parts of a farthing.

Thus,  $.7181 = 14s. 4d. 2f.$  by inspection; but by the common method, and by inspection corrected, the answer comes out 1 farthing less, as follows.

<i>Common method.</i>	<i>Inspection corrected.</i>
L.	If 25 : 1 :: 18 : .72.
.718	that is, 25)18.0(.72
20	17 5
s. 14.360	50 and 18
12	50 .72
d. 4.32	(0) 17.28
4	
f. 1.28	d. f. And 17.28 = 4 1.28

To conclude, instead of dividing by 25, we may multiply by .04; and then the exact value of any decimal of a pound Sterling may be found as follows.

From the primes and seconds set off the shillings; multiply the remainder by 4, setting the product two places to the right; subtract the product from the first remainder; and from the second remainder point off so many places to the right as there are figures in the first remainder. The number on the left of the point is farthings, and the figures on the right are a decimal of a farthing.

*Example 1.*  
s. d. f.  
 $.7181 = 14 \ 4 \ 1.28$

1 Rem. .18  
 $72 = 18 \times 4$   
2 Rem. 17.28

*Example 2.*  
s. d. f.  
 $.76911 = 15 \ 4 \ 2.336$

1 Rem. 191  
 $764 = 191 \times 4$   
2 Rem. 18.336

PROB. V. To reduce a decimal to its primitive vulgar fraction.

CASE I. When the given decimal is finite.

RULE. Divide both numerator and denominator of the given decimal by their greatest common measure; the quot is the vulgar fraction required.

Thus,  $.875 = \frac{875}{1000} = \frac{7}{8}$ . For 875)1000(1

Greatest common measure 125)875(7  
875  
(0)

And 125)1000(8

CASE II. When the given decimal is a pure repeater, or a pure circulate.

RULE. Make the repeating figure, or the figures of the circle, the numerator of the vulgar fraction; the de-

nominator is 9 for the repeating figure, or 9 for every figure of the circle; and then, if occasion require, reduce this fraction to its lowest terms.

Thus,  $.3 = \frac{3}{9} = \frac{1}{3}$ , and  $.6 = \frac{6}{9} = \frac{2}{3}$ , and  $.9 = \frac{9}{9} = 1$ .

Again,  $.27 = \frac{27}{99} = \frac{3}{11}$ , and  $.714285 = \frac{714285}{999999} = \frac{7}{11}$ .

CASE III. When the given decimal is a mixt repeater, or a mixt circulate.

RULE. From the mixt repeater, or mixt circulate, subtract the finite part, and the remainder is the numerator of the vulgar fraction; the denominator is 9 for the repeating figure, or 9 for every figure of the circle, with as many ciphers annexed as there are figures in the finite part.

Thus,  $.03 = \frac{3}{90} = \frac{1}{30}$ , and  $.16 = \frac{16}{90} = \frac{8}{45}$ , and  $.08\bar{3} = \frac{83}{990} = \frac{8}{111}$ .

The reason of the rule may be shewn thus: Esteem the finite part of the last example an integer, and then the mixt number  $3\frac{714285}{999999}$  will be equal to the given circulate. Again, reduce this mixt number to an improper fraction, viz. multiply the integer 3 by the denominator 999999, and to the product add the numerator, as directed in reduction of vulgar fractions.

Multiply the integer 3 into 999999 by the method of multiplying any number by 9, 90, 999, &c. taught in multiplication of integers, and to the product add the numerator, and the sum shall be the numerator of the improper fraction, as in the margin.

3000000  
3  
2999997  
571428  
3571425 num.

Now it is evident that the same numerator will be found, if, in the upper line, instead of the six ciphers, you place the figures of the circle, and from them subtract 3, the finite part.

3571428  
3  
3571425 num.

To the numerator thus found, the denominator is 999999; and so the vulgar fraction is  $\frac{3571425}{999999}$ . But we esteemed 3 an integer; whereas, in fact, it is  $\frac{3}{10}$ ; and so our vulgar fraction will be 100 times greater than it ought to be: to correct this error, we must multiply the denominator by 100, which is done by annexing two ciphers to it; and the true fraction comes out to be  $\frac{3571425}{99999900}$ , as by the rule.

Because this rule is of great importance, and will often occur in practice, we shall here subjoin another example.

Reduce .0416 to a vulgar fraction.

.0416  
416  
Num. 375  
Den. 9000 =  $\frac{1}{24}$

In this manner too may any mixt number, consisting of an integer with a repeater or circulate, be reduced to an improper vulgar fraction; but no ciphers are to be annexed to the denominator for the figures of the integer.

Ex. Reduce 8.3 to an improper vulgar fraction.

$$\begin{array}{r} 8.3 \\ \underline{8} \\ \text{Num. } 75 \\ \text{Den. } 9 \end{array} = \frac{75}{9} = 8\frac{1}{3}$$

Approximate decimals being imperfect, cannot be exactly reduced back to the vulgar fractions from which they resulted. But if the approximate be completed by annexing to it a vulgar fraction, whereof the remainder of the division is the numerator, and the divisor the denominator, you shall have a mixt number, which you may reduce to an improper vulgar fraction; then to the denominator annex as many ciphers as there are figures in the approximate; and this fraction reduced to its lowest terms, will be the primitive vulgar fraction required.

PROB. VI. To reduce unlike circles to others that are similar and conterminous.

Similar or like circles are such as consist of an equal number of places.

Thus, .27, and .09, are similar circles, as consisting of two places each. But .63, and .148, are unlike; the former consisting of two, and the latter of three places.

Conterminous circles are such as begin and end at the same distance from the decimal point.

Thus, .153846, and .384615, are conterminous; because they both begin at the place of primes, and have an equal number of places. And .0,714285, and .7857142, are conterminous, because they both begin at the place of seconds, and have the same number of places. But .81, and .1,36, are not conterminous, the former beginning at the place of primes, and the latter at the place of seconds. Again, .63, and .481, are not conterminous, because they have not the same number of places; for circles cannot be conterminous unless they be at the same time similar.

Unlike circles are reduced to similar ones by the following

RULE. Find the least multiple of the numbers denoting the number of places in the several given circles, and extend each of the given circles to as many places as there are units in the least multiple.

Thus, to reduce the unlike circles .63, = .636963, .63, and .148, to similar ones, extend both circles to six places, because 6 is the least multiple of 2 and 3, the number of places in the given circles.

In a circle any one of the circulating figures may be made the first of the circle. Thus, 7.592, may be expressed thus, 7.5,925; or thus, 7.59,259; and that without changing its value: consequently a pure circulate may put on the form of a mixt circulate, if one or more figures on the left be set aside for the finite part; thus, .72, = .7,27, where .7, is the finite part.

That the value is not changed may be thus demonstrated.

$$.727 = \frac{720}{999} = \frac{72}{99} = .72$$

Hence two or more given circles may be made conterminous, by the following

RULE. Set aside by a comma on the left, as many figures as there are places in the longest finite part, and then prolong the several circles to as many places as will make them similar.

Ex. To make .54,63, and .54,63, = .54,636363, .9,148, conterminous. .9,148, = .91,481481,

Here, because .54, the longest finite part, consists of two places, set aside .91, in the other circulate, for a finite part, and then prolong both circles to six places, which renders them similar.

### III. Addition of Decimals.

RULE I. Place the given decimals so that the points may stand directly under each other, and consequently tenths under tenths, hundredths under hundredths &c.; then, if the given decimals be all finite or approximate, add them as integers, inserting the decimal point directly under the column of points. The figures on the left of the point are integers, and those on the right are a decimal of the integer, consisting of as many places as there are figures in the longest of the given decimals.

The operation is the same here as in addition of vulgar fractions; for a cipher on the right of a decimal does not change its value: If, therefore, ciphers be annexed, so as to give every decimal the same number of places, as is done in the margin, they will by this means be reduced to a common denominator, viz. 1000.

Note. If the decimals to be added are of different denominations, first reduce them to one denomination, and then add. The reason is, because like things only can be added or subtracted.

Ex. What is the sum of .725 l. and 625 s.?

Here you may either reduce the decimal of a shilling to that of a pound, or you may reduce the decimal of a pound to that of a shilling.

First reduce the decimal of a shilling to that of a pound, by reduction ascending, viz. divide by 20, as follows.

$$\begin{array}{r} 20).62500(.03125 \\ \underline{.725} \\ \text{Sum } .75625 = 15 \frac{1}{2} \end{array}$$

Secondly, reduce the decimal of a pound to that of a shilling, by reduction descending; that is, multiply by 20, as follows.

$$\begin{array}{r} .725 \text{ l.} \\ \underline{20} \\ \text{s. } 14.500 \\ \underline{625} \\ \text{s. } 15.125 \text{ sum.} \\ \underline{12} \\ \text{d. } 1.500 \\ \underline{4} \\ \text{s. } 2.0 \end{array}$$

Answers-

APPROXIMATES.

If the decimals to be added run on to a great many places, it will be sufficient in most cases to use only four or five places, and observe to increase the figure at which you break off by an unit, if the rejected figure on the right exceed 5. And in adding such approximates, omit the right-hand figure of the sum, as uncertain, but take in the carriage. Follows an example at large, and the same contracted.

<i>Ex. at large.</i>	<i>contracted.</i>
12.2352946	12.23529 +
8.15789325	8.15789 +
7.086968435	7.08696 —
6.32143482	6.32143 +
4.75	4.75
<hr/>	<hr/>
38.551591105	38.5515 certain.

**RULE II.** When all or any of the given decimals are repeaters, give every repeater the same number of places, and one place more than the longest finite; and for every nine in the right-hand column carry 1. or to its sum add 1 for every nine, and then carry at ten.

*Examp.*

$748\frac{1}{9} =$	748.83
$653\frac{2}{9} =$	653.86
$84\frac{4}{9} =$	84.88
$25\frac{5}{9} =$	25.83
$37\frac{7}{9} =$	37.85
$8\frac{8}{9} =$	8.88

$1557\frac{8}{9} = 1557.86$

In this example the sum of the right-hand column is 24, which contains 9 twice, and 6 over; so set down 6 and carry 2: Or to the sum 24 add 2, for the two nines, which makes 26; so set down 6 and carry 2. Proceed with the rest as in integers.

The sums, differences, and products, of interminate decimals, are always interminate, unless they end in a cipher.

A repeating digit is the numerator of a vulgar fraction, whose denominator is 9; and hence, in adding a column of repeating digits, every 9 of the sum is  $\frac{2}{9}$ , or an unit, to be carried; and what is over a just number of nines is so many ninth-parts.

Or, if to the sum of a column of repeating digits, 1 for every 9 contained in it be added, we then carry 1 for every ten; but what is over a just number of tens will still continue to be ninth-parts.

If in any example the repeating figures happen all to be reiterated, the carriage from the right-hand column adjusts the column on the left, or makes every ten of them equal to an unit of the next superior column, &c. Thus, if we imagine a column of the repeating figures reiterated on the right of any example, the carriage from it would adjust the right-hand column of the example.

**RULE III.** When all or any of the given decimals are circulates, make all the circles conterminous, and the number of tens to be carried from the left-hand column

of the circles, add this carriage to the right-hand column, and proceed as in addition of integers.

If repeaters be mixed with the circulates, give the repeaters the form of circulates, by extending the repeating figures till they become conterminous with the other circles.

If finite decimals are joined with the circulates, extend the finite parts of all the circulates to as many places as there are figures in the longest finite.

**EXAMP.**

$\frac{1}{9} =$	.428571, =	.428571,
$\frac{2}{9} =$	.857142, =	.857142,
$\frac{4}{9} =$	.45, =	.454545,
$\frac{10}{9} =$	.370, =	.370370,
		<hr/>
		2.110630

In order to find the carriage from the left-hand column of the circles, add the column next to it on the right, saying,  $7 + 5 + 5 + 2 = 19$ ; from which carry 1, and say,  $1 + 3 + 4 + 8 + 4 = 20$ ; from which carry 2, and go on to add the right-hand column of the circle, saying, the carriage  $2 + 5 + 2 + 1 = 10$ ; so set down 0, and carry 1, and proceed with the rest as in integers.

The adding the carriage from the left-hand column of the circles to the column on the right hand, arises from the flux of numbers; for as the circles repeat infinitely, if we suppose a new set of the same circles to be repeated upon the right of our examples, it is plain, that in adding them the carriage from the left-hand column of the new set would naturally fall into the right-hand column of our example.

The operation here is the same as in addition of vulgar fractions; for every circle is the numerator of a vulgar fraction, whose common denominator is 999999; and if the circles or numerators be added, without minding any carriage from the left-hand column, the sum will be 2110628.

And  $999999)2110628(\frac{2110628}{999999}$   
 $1999998$   


---

 110630

But, by pointing off from the sum of the circles six figures towards the right, we divide by 1000000, instead of dividing by 999999; which gives indeed the same quot, but makes the remainder too small.

Now, that the carriage-figure from the left-hand column of the circles, is the integral part of the quot, and at the same time the difference between the true and false remainder, is evident; for the quotient-figure 2, multiplied into the two divisors 1000000 and 999999, gives two products, whose difference is 2; and consequently, if the greatest product, viz.  $2 \times 1000000 = 2000000$ , be subtracted from the dividend, the result will want 2 of the true remainder. To prevent such errors; and to put the work on a sure footing, find the carriage from the left-hand column of the circles, add this carriage to the right-hand column, divide the sum by 1000000, and you will have a true quot, and a true remainder. The learner may look back to division of integers.

integers, where the method of dividing by 9,99,999, &c. is explained.

.428571,  
.857142,  
.154545,  
.370370,  
-----  
2.110628  
2  
2.110630,

Hence it follows, that if we add the circles as they stand, without minding any carriage from the left, and to the sum add the excrescent figure on the left of the decimal point, we shall have the full sum of the circles, both as to the integral and fractional part, as in the margin:

Pure repeaters, being the numerators of vulgar fractions, whose denominator is 9 as often taken as the digit is repeated, may be added in the same manner as circles. But in examples clear of circulates, the method prescribed in Case II. is preferable.

.857142, .6666,  
.571428, .6666,  
.857142, .6666,  
.714285, -----  
1.9999,  
2.999999, 1  
1  
-----  
3.000000 2.0000

In adding circles and pure repeaters by the method now explained, it will sometimes happen that the fractional part of the sum will be a series of nines, as in the margin: And in this case, the numerator of the fraction being the same with the denominator, its value will be unity; and accordingly 1 must be

added to the integral part. But in adding pure repeaters by the method in Case II. this cannot happen.

By way of proof, we shall here add all the vulgar fractions in Examp. I. and reduce their sum to a mixed number, continuing the division to a decimal.

$$\frac{7}{9} + \frac{5}{9} + \frac{7}{9} + \frac{1}{9} = \frac{21}{9} + \frac{11}{9} + \frac{7}{9} + \frac{1}{9} = \frac{40}{9} = 4\frac{4}{9}$$

$$14553)30716(2.110630, \\ 29106$$

$$\begin{array}{r} *16100 \\ 14553 \\ \hline 15470 \\ 14553 \\ \hline \end{array}$$

$$\begin{array}{r} 91700 \\ 87318 \\ \hline \end{array}$$

Here the dividial being the same with the second, a new circle begins.

$$\begin{array}{r} 43820 \\ 43659 \\ \hline *16100 \end{array}$$

IV. Subtraction of Decimals.

**RULE I.** Place the minor under the major, so that that the points may be in one column; and then, if the given decimals be finite or approximate, work as in subtraction of integers.

If the major and minor have not the same number of places, imagine the void places to be filled up with ciphers.

EXAMPLE I.

L. s. d. L.  
From 48 10 6 = 48.525  
Sub. 18 12 8  $\frac{1}{4}$  = 18.634375  
-----  
Rem. 29 17 9  $\frac{1}{4}$  = 29.890625

EXAMPLE II.

C. Q. lb. C.  
From 54 2 21 = 54.6875  
Sub. 36 3 14 = 36.875  
-----  
Rem. 17 3 17 = 17.8125

APPROXIMATES.

In subtracting approximates, neglect the right-hand figure of the remainder, as uncertain; but an unit borrowed on the right must be repaid, as in the two examples following.

Ex. 1. Ex. 2.  
From 783.0625 From 549.4643  
Sub. 495.28571 + Sub. 78.0875  
-----  
Rem. 287.7767 certain. Rem. 471.376 certain.

**RULE II.** If one of the given decimals is a repeater, and the other a finite decimal, give the repeater one place more than the finite decimal, and in subtracting borrow 9 on the right hand.

But if both major and minor repeat, give them an equal number of places, and then subtract as above.

Ex. 1. Ex. 2. Ex. 3.  
From .7145833 .525 .9989583  
Sub. .634375 .8333 .0291866  
-----  
Rem. .0802083 .1916 .9697916

In Ex. 1. and 2. you give the repeater one place more than the finite decimal, and by this means you obtain the repeating figure of the remainder. But in Ex. 3. you give the two repeaters an equal number of places.

In Ex. 2. and 3. you borrow 9 on the right hand.

**RULE III.** If both the given decimals be circulates, make the circles conterminous, and work as in integers; only if, in the left-hand column of the circles, you foresee, that, in subtracting the figure of the minor from that of the major, one must be borrowed, in this case add 1 to the right-hand figure of the minor, and then subtract.

If one of the given decimals be a circulate, and the other a repeater, give the repeater the form of a conterminous circulate, and then subtract as above.

If one of the given decimals be a circulate, and the other a finite decimal, extend the finite part of the circulate to as many places as there are figures in the finite decimal, and then subtract.

EXAMP. I. From  $\frac{7}{9}$  = .6,428571, = .64,285714,  
Sub.  $\frac{1}{4}$  = .17,857142, = .17,857142,  
-----

Rem. .46,428571.  
In this example, because, in the left-hand column of the

the circles, 8 cannot be subtracted from 2 without borrowing; therefore add 1 to the right-hand figure of the minor, and say,  $1+2=3$ , and 3 from 4, and 1 remains. The reason is obvious: for, supposing the circles reiterated on the right of the example, it would be, 8 from 2 you cannot, but 8 from 12 and 4 remains; 1 borrowed, and 2, make 3, &c.

EXAMPLE II.

$$\begin{array}{r} \text{From } \frac{1}{4} = .9,285714, = .9,285714, \\ \text{Sub. } \frac{2}{7} = .\beta \quad = .\beta,666666, \end{array}$$

Rem. .2,619047.

In the above example the repeaters are given in the form of conterminous circulaters.

EXAMPLE III.

$$\begin{array}{r} \text{From } \frac{1}{7} = .384615, = .384,615384, \\ \text{Sub. } \frac{1}{8} = .125 \quad = .125 \end{array}$$

Rem. .259,615384.

In the last example the finite part of the circulate is extended to as many places as there are figures in the finite decimal, by which means like things come to be subtracted, and you obtain the exact circle of the remainder.

V. Multiplication of Decimals.

In multiplication and division there may happen nine varieties, arising from the different nature of the numbers that may occur in the operation; and these are of three sorts, viz. integers, mixt numbers, and pure decimals.

Now, since the multiplier or divisor may be of three kinds, and the multiplicand or dividend of as many, there must of consequence be nine varieties; which are these following.

- An integer may multiply or divide
- A mixt number may multiply or divide
- A pure decimal may multiply or divide

- a integer,
- a mixt number,
- a pure decimal.
- a integer,
- a mixt number,
- a pure decimal,
- a integer,
- a mixt number,
- a pure decimal.

Of these varieties, the first belongs properly to vulgar arithmetic, the other eight occur in decimal operations.

But in multiplication and division of decimals, there will occur other nine varieties, arising likewise from the nature of the numbers; which may either be finite, repeating, or circulating.

And since the multiplier or divisor may be of three sorts, and the multiplicand or dividend of as many, there must of course be nine varieties; and these are so obvious, that it would be losing time here to enumerate them.

Before entering on multiplication, we shall lay down a rule for pointing the product, which is of a general nature, and extends to decimals of every sort, whether finite, repeating, or circulating; and is as follows.

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GENERAL RULE.

Give so many decimal places to the product, on the right, as are in both factors; and if the product has not so many figures, supply that defect by prefixing ciphers.

We now proceed to multiplication.

RULE I. If both factors are finite or approximate, work exactly as in multiplication of integers.

Ex. 1.	Ex. 2.
.785	.125
.75	.25
-----	-----
3925	625
5495	250
-----	-----
.58875	.03125

In Ex. 2. the product not affording so many decimal places as are in the multiplicand and multiplier, the defect is supplied by prefixing ciphers.

The reason of giving as many decimal places to the product as are in both factors, appears by considering that the operation is the same here as in multiplication of vulgar fractions. Thus,  $.785 \times .75 = \frac{785}{1000} \times \frac{75}{100} = \frac{58875}{100000} = .58875$ .

To multiply by 10, 100, 1000, &c. move the decimal point so many places toward the right hand as there are ciphers in the multiplier.

Thus:

$$\begin{array}{l} .4375 \times 10 = 4.375 \\ .4375 \times 100 = 43.75 \end{array}$$

And thus:

$$\begin{array}{l} 6.875 \times 10 = 68.75 \\ 6.875 \times 100 = 687.5 \end{array}$$

APPROXIMATES.

In multiplying approximates, the certain places of the product may be determined by one or other of the two rules following, viz.

1. If both factors are approximates, the uncertain places of the product will be one more than the number of places in the longest factor.
2. If one of the factors be finite, and the other approximate, the uncertain places of the product will be one more than the number of places in the finite factor.

Ex. 1.	Ex. 2.
245.118—	.240526†
.3529†	2.875
-----	-----
2206063	1052630
490236	1473682
1225590	1684208
735954	421052
-----	-----
86.5021422	.605262250

In Ex. 1. the integral part of the product, viz. 86, is certain, and all the decimal places on the right are uncertain. In Ex. 2. only four places on the left, viz. .6052, are certain, and all the other places uncertain.

The reason of Rule 1. is plain. For if in Ex. 1. we make the longest factor the multiplier; and the total product will be the same either way, it is obvious, that in this case we shall have six particular products; in each of which the right-hand figure will be uncertain, and consequently

5 K

consequently we shall have six uncertain places in the total product toward the right, and also one uncertain place more on account of the uncertain carriage from the column in which the right-hand figure of the last particular product stands.

The reason of Rule 2. is also obvious. For in Ex. 2. by making the finite factor the multiplier, we have four particular products, in each of which the right-hand figure is uncertain; and so we have four uncertain places in the total product, and one uncertain place more arising from the uncertain carriage.

The carriage in some cases may affect several columns on the left, and thereby render so many more figures uncertain.

The surest way therefore to determine the certain places in the product of approximates, is by a second operation, giving the approximates contrary signs; for then, so far as the two products agree, the figures are certain. The second operations of the two former examples follow.

<i>Ex. 1.</i>	<i>Ex. 2.</i>
245.117+	.210527-
.353-	2.875
-----	-----
735351	1052635
1025585	1473689
735351	1684216
-----	-----
86.526301	421054
	-----
	.605265125

In Ex. 1. 86.5 is certain, and all the other figures uncertain. In Ex. 2. .60526 are the only certain places.

Because the multiplication of decimals that consist of many places, proves, in the way hitherto practised, a tedious operation, we shall here explain a method whereby decimals of this sort, whether finite or approximate, may be multiplied expeditiously, and at the same time have the decimal places in the product limited to any number proposed. This may be effected by the following

**RULE.** Under the multiplicand place the multiplier inverted, so that its units place may stand under that place of the multiplicand to which you propose to limit the product; then multiply the right-hand figure of the multiplier into that figure of the multiplicand which stands directly over it, taking in the carriage from the right, and go on to multiply it into all the other figures on the left. Proceed in like manner with every other figure of the multiplier, placing the right-hand figures of all the particular products directly under other. The total product will be approximate, and the right-hand figure uncertain.

To make this rule more easily understood, the reader may look back to the multiplication of integers; where it was observed, that instead of beginning with the right-hand figure of the multiplier, we may begin with the left, and still have a just product; provided the right-hand figure of every particular product be placed directly under the multiplying figure. Now, the working an example, both in this manner, and also by the rule, and comparing the steps and results of the two opera-

tions, will throw a light upon the matter, and unfold the reason of the rule. Which take as follows.

Multiply 18.634375 into 9.875, and limit the product to four decimal places.

By the rule.	By the other method.
18.634375	18.634375
578.9	A 9.875
-----	-----
1677093	1677093 75
149075	149075 000
13044	13044 0625
931	931 71875
-----	-----
184.0143+	184.0144 53125
	B

In working by this rule, you invert the multiplier, and place 9, the units figure, under 3, the fourth place of decimals, because the product is limited to four decimal places; then multiply, saying,  $9 \times 3 = 27$ , and 6 carried from the right makes 33, &c. In multiplying by 8, say,  $8 \times 4 = 32$ , and 3 of carriage makes 35; so set 5 under 3; and proceed in like manner to multiply the figures on the left. The right-hand figure of the product is defective, as wanting the carriage from the columns cut off on the right by the line A B. The figures expressing the sum of the columns so cut off, are so many uncertain places of the product, when the factors are approximate, and on that account to be rejected as useless. The figures, moreover, on the right of the line A B, show how far the operation is contracted, or how much labour is saved in working by the rule.

If there be no units in the multiplier, in this case set the right-hand figure of the inverted multiplier under that figure of the multiplicand, below which it would have stood had there been units.

Ex. Multiply .825 by .825, limiting the product to three decimal places.

By the rule.	The common way at large.
.825	.825
528.	.825
-----	-----
660	4125
16	1650
4	6600
-----	-----
.680+	.680625

The decimal places of the factors may either be retained at full length, or turned into approximates before you begin to multiply.

Ex. Multiply 25.849013625 by 42.97235, limiting the product to two decimal places.

25.849013625
52279.24
-----
103396
5169
2326
180
-----
5.
-----
1110.76+

We



We shall next turn the decimals of the former example into approximates, and then the operation will be as follows.

By the rule.	Common way at large.
25.85— +79.24	25.85— 42.97+
103400 5170 2326 180	18095 23265 5170 10340
Prod. 1110.76+	1110.7745

It remains to be observed, that the want of carriage from the right hand may sometimes affect more columns on the left than one, and thereby occasion more uncertain figures in the product than that on the right hand. The best security on this head is, never to limit the product to fewer than four or five decimal places.

To conclude, when decimals to be multiplied are long, you may frequently perform the operation more easily in vulgar fractions, and then reduce the product to a decimal.

**RULE II.** If the multiplier be finite, and the multiplicand repeat, in multiplying carry at 9 on the right hand; and before you add, prolong the repetends of the particular products, till their right-hand figures stand directly under one another; and in adding, carry at 9 on the right hand.

The product repeats, as in Ex. 1. 2. &c.; or turns out finite, as in Ex. 6.

<i>Ex. 1.</i> $\begin{array}{r} .3 \\ 4 \\ \hline 1.2 \end{array}$	<i>Ex. 2.</i> $\begin{array}{r} .1\beta \\ 7 \\ \hline 1.1\beta \end{array}$	<i>Ex. 3.</i> $\begin{array}{r} 27.083 \\ .5 \\ \hline 13.541\beta \end{array}$	<i>Ex. 4.</i> $\begin{array}{r} 354.2\beta \\ .0\beta \\ \hline 28.341\beta \end{array}$
<i>Ex. 5.</i> $\begin{array}{r} 4.0\beta \\ 5.2 \\ \hline 81\beta \\ 2033\beta \\ \hline 21.14\beta \end{array}$	<i>Ex. 6.</i> $\begin{array}{r} 6.4\beta \\ 123 \\ \hline 1930 \\ 1286\beta \\ 6433\beta \\ \hline 791.30 \end{array}$		

*Note.* If the multiplier has ciphers on the right, instead of annexing ciphers to the product, reiterate its right-hand figure so many times as there are ciphers.

<i>Ex. 1.</i> $\begin{array}{r} 79.\beta \\ 50 \\ \hline 3983.3 \end{array}$	<i>Ex. 2.</i> $\begin{array}{r} 874\beta \\ 900 \\ \hline 786900.0 \end{array}$
---	--

**RULE III.** If the multiplier be finite, and the multi-

plicand circulate, to the product of the right-hand figure of the circle add the carriage from the left, then proceed as in multiplication of integers; but before you add the particular products, make them conterminous, and then add as in addition of circulates.

The product commonly circulates; and then its circle is similar to the circle of the multiplicand, as in Ex. 1. and 2.; but the product sometimes repeats, as in Ex. 5.; or it may turn out finite, as in Ex. 6.

Here it is obvious, that in multiplying .481 *Ex. 1.* by 7, the carriage from the left would be 3; *.481,* so say,  $7 \times 1 = 7$ , and 3 of carriage, make 10, *7,* &c. The product circulates, and its circle.  $\frac{370}{3.370}$ , is similar to .481, the circle of the multiplicand.

<i>Ex. 2.</i> $\begin{array}{r} 7.518, \\ .5 \\ \hline 3.7.592, \end{array}$	<i>Ex. 3.</i> $\begin{array}{r} 7.518, \\ .05 \\ \hline .37.592, \end{array}$	<i>Ex. 4.</i> $\begin{array}{r} 7.518, \\ .005 \\ \hline .037.592, \end{array}$
---	--	--

In the above three examples the products are mixt circulates, the three figures on the right being the circle, and the figures on the left the finite parts.

**RULE IV.** If the multiplier be interminate, reduce it to a vulgar fraction, as directed in reduction of decimals, Prob. V.; then multiply the given multiplicand by the numerator, (working as in integers, if the multiplicand be finite; or as directed in Rule 2. if it repeat; or as prescribed in Rule 3. if it circulate); and divide the product by the denominator.

Here there are six cases; for the multiplier may repeat, or circulate, and may multiply a finite, a repeating, or circulating multiplicand.

**CASE I.** When a repeating multiplier multiplies a finite multiplicand.

**EXAMP.** Multiply 638.25 by  $.4 = \frac{2}{5}$

638.25	
4	
2553.00	(283.6 product sought.)
18	
75	
72	
33	
27	
60	
34	
*6	

**CASE II.** When both factors repeat.

**EXAMPLES**

EXAMP. Multiply  $6.8\bar{3}$  by  $\frac{1}{7} = \frac{1}{7}$

$$\begin{array}{r} 6.8\bar{3} \\ \underline{7} \\ 9)47.8\bar{3} \text{ (5.3, 148, prod.)} \\ 45 \phantom{00} \\ \hline 28 \\ 27 \\ \hline * 13 \\ 9 \\ \hline 43 \\ 36 \\ \hline 73 \\ 72 \\ \hline * 1 \end{array}$$

In dividing by 9, after the dividend is exhausted, continue the division by annexing to the remainders the repeating figure of the dividend; and the quot or product sought comes out a mixt circulate.

CASE III. When a repeating multiplier multiplies a circulating multiplicand.

EXAMP. Multiply  $24.36$ , by  $\frac{4}{9} = \frac{4}{9}$

$$\begin{array}{r} 24.36 \\ \underline{4} \\ 9)97.45 \text{ (10.82, prod.)} \\ 9 \\ \hline * 74 \\ 72 \\ \hline 25 \\ 18 \\ \hline * 74 \end{array}$$

In multiplying by 4, take in the carriage from the left of the circle; and in dividing by 9, continue the division by annexing to the remainders the circulating figures of the dividend.

CASE IV. When a circulate multiplies a finite multiplicand.

EXAMP. Multiply  $825$  by  $\frac{36}{99} = \frac{4}{11}$

$$\begin{array}{r} 825 \\ \underline{36} \\ 4950 \\ 2475 \\ \hline 99)29700 \text{ (300 product)} \\ 297 \end{array}$$

CASE V. When a circulate multiplies a repeating multiplicand.

EXAMP. Multiply  $8.0208\bar{3}$  by  $\frac{72}{99} = \frac{8}{11}$

$$\begin{array}{r} 8.0208\bar{3} \\ \underline{72} \\ 160416\bar{6} \\ 561458\bar{3} \\ \hline 99)577.50000 \text{ (5.8\bar{3})} \\ 495 \phantom{00} \\ \hline 825 \\ 792 \\ \hline 330 \\ 297 \\ \hline * 33 \end{array}$$

CASE VI. When both factors circulate.

EXAMP. Multiply  $.71428\bar{5}$ , by  $\frac{36}{99} = \frac{4}{11}$

$$\begin{array}{r} .71428\bar{5} \\ \underline{36} \\ 4,285714, \\ 21,428571, \\ \hline 99)25,714285,7 \\ 257142,8 \\ 2571,4 \\ 25,7 \end{array}$$

Prod.  $.25,974025 = .259740.2\bar{5}$

The circle of the first product is always similar to that of the multiplicand, and in the above example consists of six places; but to secure the carriage from right to left, and thereby complete the circle of the quot or total product, transfer 7, the left-hand figure of the circle of the first product, to the right, and fill up the places under it with the figures that come in course, and from the sum of these figures on the right carry 2, which completes the circle of the total product.

VI. Division of Decimals.

BEFORE we enter on division, it will be proper to observe, that there are two rules for pointing the quot, both which are general in their nature, and extend to decimals of every sort, whether terminate or interminate; but unwilling to perplex the learner with too many things at once, we shall at present lay down only one of these rules; and afterwards, when the rule now to be assigned appears to be sufficiently exemplified, shall then bring the other rule upon the field.

GENERAL RULE.

The decimal places in the divisor and quot together must always be equal in number to those of the dividend.

The

The five following practical directions will make the application of the general rule easy.

1. When the divisor and dividend have an equal number of decimal places, the quot comes out an integer; as in Ex. 2.

2. When the decimal places of the dividend are more than those of the divisor, the number of decimal places in the quot must be equal to the excess; as in Ex. 1. 4. and 8.

3. When the decimal places of the divisor are more than those of the dividend, annex ciphers to the dividend, so as to make them equal, and the quot, by direction 1. will be integers; as in Ex. 3. 5. and 7.

4. When, after division is finished, the quot has not so many figures, as, by the general rule, it ought to have decimal places, supply that defect by prefixing ciphers; as in Ex. 6.

5. If, after the dividend is exhausted, there be a remainder, annex a cipher, or ciphers, to the remainder, and continue the division till 0 remain, or till the quot repeat or circulate, or till you think proper to limit it; as in Ex. 9. 10. 11. and 12.

We now proceed to division.

**RULE I.** If the divisor and dividend are both finite or approximate, work exactly as in division of integers.

$$\begin{array}{r} \text{Ex. 1.} \\ .75)58875(.785 \\ \underline{525} \phantom{00} \\ 637 \phantom{00} \\ \underline{600} \phantom{00} \\ 375 \\ \underline{375} \\ 0 \end{array}$$

$$\begin{array}{r} \text{Ex. 2.} \\ 2.5)182.5(.73 \\ \underline{175} \phantom{00} \\ 75 \\ \underline{75} \\ 0 \end{array}$$

In Ex. 1. A decimal divides a decimal; and because the dividend has five decimal places, and the divisor only two, give three decimal places to the quot, according to Direction 2.

In Ex. 2. A mixt number divides a mixt number, and the divisor and dividend having an equal number of decimal places, the quot comes out an integer, according to Direction 1.

The reason of the rule for pointing the quot is obvious; for multiplication gives as many decimal places to the product as are in both factors; but the dividend is the product of the divisor and quot, and so has as many decimal places as are in both; consequently the decimal places in the divisor and quot together must be equal in number to those of the dividend.

$$\begin{array}{r} \text{Ex. 3.} \\ .85)476( \\ \underline{.85)476.00(.560} \\ 425 \phantom{00} \\ \underline{510} \phantom{00} \\ 510 \\ \underline{510} \\ 0 \end{array}$$

$$\begin{array}{r} \text{Ex. 4.} \\ 7).875(.125 \\ \underline{7} \phantom{00} \\ 17 \\ \underline{14} \\ 35 \\ \underline{35} \\ 0 \end{array}$$

In Ex. 3. A decimal divides an integer; and the dividend having no decimal place, annex two ciphers, be-

cause there are two decimal places in the divisor, and the quot comes out an integer, according to Direction 3.

In Ex. 4. An integer divides a decimal; and because the dividend has three decimal places, and the divisor none, give the quot three, by Direction 2.

$$\begin{array}{r} \text{Ex. 5.} \\ .375)12.75( \\ \underline{.375)12.750(.34} \\ 1125 \\ \underline{1500} \\ 1500 \\ \underline{1500} \\ 0 \end{array}$$

$$\begin{array}{r} \text{Ex. 6.} \\ 2.5).22875(.0915 \\ \underline{225} \\ 37 \\ \underline{25} \\ 125 \\ \underline{125} \\ 0 \end{array}$$

In Ex. 5. A decimal divides a mixt number; and the divisor having three decimal places, and the dividend but two, supply that defect by annexing a cipher, and the quot comes out an integer, by Direction 3.

In Ex. 6. A mixt number divides a decimal; and because the dividend has four decimal places more than the divisor, and the quot, after the division is finished, has only three figures, supply this defect by prefixing a cipher to it, according to Direction 4.

$$\begin{array}{r} \text{Ex. 7.} \\ 3.75)180( \\ \underline{3.75)180.00(.48} \\ 1500 \\ \underline{3000} \\ 3000 \\ \underline{3000} \\ 0 \end{array}$$

$$\begin{array}{r} \text{Ex. 8.} \\ 38)243.2(.64 \\ \underline{228} \phantom{00} \\ 152 \\ \underline{152} \\ 0 \end{array}$$

In Ex. 7. A mixt number divides an integer; and the dividend having no decimal places, supply that defect by annexing two ciphers, the number of decimal places in the divisor, and the quot is an integer, by Direction 3.

In Ex. 8. An integer divides a mixt number; and the divisor having no decimal place, and the dividend only one, give one to the quot, according to Direction 2.

$$\begin{array}{r} \text{Ex. 9.} \\ .8)29(36.25 \\ \underline{24} \\ 50 \\ \underline{48} \\ 20 \\ \underline{16} \\ 40 \\ \underline{40} \\ 0 \end{array}$$

$$\begin{array}{r} \text{Ex. 10.} \\ .018).0024(.13 \\ \underline{18} \\ 60 \\ \underline{54} \\ 6 \\ \underline{6} \\ 0 \end{array}$$

In Ex. 9. A decimal divides an integer; and after the dividend is exhausted, annex a cipher to the remainder, and continue the division till 0 remain, according to Direction 5.

In Ex. 10. A decimal divides a decimal; and after the dividend is exhausted, annex a cipher to the remainder, and continue the division till you find the quot repeats.

Ex. 11.  

$$\begin{array}{r} 11)8( \\ 11)8.0(.72 \\ \underline{77} \\ 30 \\ \underline{22} \\ 8 \end{array}$$

Ex. 12.  

$$\begin{array}{r} 3.25)76.75(23.615+ \\ 650 \\ \underline{1175} \\ 975 \\ \underline{2000} \\ 1950 \\ \underline{500} \\ 325 \\ \underline{1750} \\ 1625 \\ \underline{125} \end{array}$$

Var. 3.  

$$\begin{array}{r} 35)32.095(.917 \\ 315 \\ \underline{59} \\ 35 \\ \underline{245} \\ 245 \\ \underline{Var. 5.} \\ 35).32095(.00917 \\ 315 \\ \underline{59} \\ 35 \\ \underline{245} \\ 245 \end{array}$$

Var. 4.  

$$\begin{array}{r} 35)3.2095(.0917 \\ 315 \\ \underline{59} \\ 35 \\ \underline{245} \\ 255 \\ \underline{Var. 6.} \\ 35).032095(.000917 \\ 315 \\ \underline{59} \\ 35 \\ \underline{245} \\ 245 \end{array}$$

In Ex. 11. An integer divides an integer; and the dividend being less than the divisor, annex a cipher to it; again, after the dividend is exhausted, annex a cipher to the remainder, and continue the division till you find the quot circulates.

In Ex. 12. A mixt number divides a mixt number: and after the dividend is exhausted, by annexing ciphers to the remainder, continue the division till the quot has three decimal places; and as there is still a remainder, it might be carried further; but three decimal places being in most cases sufficiently accurate, here you may limit it; so the quot is approximate.

In division of decimals, the place of the first figure of the quot may likewise be known from the first dividend, much after the same manner as in division of integers, by the following

II. GENERAL RULE.

The place of the first figure of the quot is the same with the place of that figure in the dividend which stands over the units of the first product.

Thus, in the example of integers in  $35)32095(917$ , the margin, the figure 0, that stands over 5, the units of the product of  $9 \times 35$ , is in the place of hundreds; and therefore 9, the first figure of the quot, is likewise hundreds; and so the quot is 917 integers.

To illustrate the rule, we shall give decimal places to the dividend of the above example; and thereby exhibit the varieties that will occur in pointing the quot.

Variety 1.  

$$\begin{array}{r} 35)3209.5(91.7 \\ 315 \\ \underline{59} \\ 35 \\ \underline{245} \\ 245 \end{array}$$

Var. 2.  

$$\begin{array}{r} 35)320.95(9.17 \\ 315 \\ \underline{59} \\ 35 \\ \underline{245} \\ 245 \end{array}$$

Var. 1.  

$$\begin{array}{r} 3.5)32095(9170 \\ 315 \\ \underline{59} \\ 35 \\ \underline{245} \\ 245 \\ \underline{0.0} \\ 0.0 \\ \underline{Var. 3.} \\ .035)32095(917000 \\ 0.315 \\ \underline{59} \\ 35 \\ \underline{245} \\ 245 \\ \underline{0.000} \end{array}$$

Var. 2.  

$$\begin{array}{r} .35)32095(91700 \\ 315 \\ \underline{59} \\ 35 \\ \underline{245} \\ 245 \\ \underline{0.00} \\ 0.000 \\ \underline{Var. 4.} \\ .0035)32095(9170000 \\ 0.0315 \\ \underline{59} \\ 35 \\ \underline{245} \\ 245 \\ \underline{0.0000} \end{array}$$

In Var. 1. say,  $9 \times 35 = 315$ ; and the unit 1 standing under the place of thousands, the figure 9 is also thousands; and as 0 at last remains, annex a cipher for the decimal .5 in the divisor; then dividing, you get 0 to the quot; and because 9 stands in the place of thousands, the quot is wholly integers.

In Var. 2. the unit 3 stands under the place of ten-thousands, and so 9 is ten-thousands; and to the remainder 0 annex .00, for the two decimal places in the divisor; then dividing, you get 00 to the quot; and because 9 stands in the place of ten-thousands, the quot continues to be wholly integers. The process is the same in Var. 3. and 4.

Lastly, we shall allow decimal places to both dividend and divisor.

Var. 1.  

$$\begin{array}{r} 3.5 \overline{) 320.95(91.7} \\ 31.5 \phantom{00} \phantom{00} \phantom{00} \\ \hline \end{array}$$

$$\begin{array}{r} 59 \\ 35 \\ \hline \end{array}$$

$$\begin{array}{r} 245 \\ 245 \\ \hline \end{array}$$

Var. 3.  

$$\begin{array}{r} .35 \overline{) .32005(.917} \\ .315 \phantom{00} \phantom{00} \phantom{00} \\ \hline \end{array}$$

$$\begin{array}{r} 59 \\ 35 \\ \hline \end{array}$$

$$\begin{array}{r} 245 \\ 245 \\ \hline \end{array}$$

Var. 2.  

$$\begin{array}{r} 3.5 \overline{) 32.095(9.17} \\ 31.5 \phantom{00} \phantom{00} \phantom{00} \\ \hline \end{array}$$

$$\begin{array}{r} 59 \\ 35 \\ \hline \end{array}$$

$$\begin{array}{r} 245 \\ 245 \\ \hline \end{array}$$

Var. 4.  

$$\begin{array}{r} 3.5 \overline{) .32095(.0917} \\ .315 \phantom{00} \phantom{00} \phantom{00} \\ \hline \end{array}$$

$$\begin{array}{r} 59 \\ 35 \\ \hline \end{array}$$

$$\begin{array}{r} 245 \\ 245 \\ \hline \end{array}$$

In Var. 1. the units of the first product stand under tens of the dividend; and so 9, the first figure of the quot, is tens. In Var. 2. the units of the first product stand under units of the dividend, and so 9 is units. In Var. 3. the units of the first product stand under primes, and so 9 is primes, &c.

To divide by 10, 100, 1000, &c. is to move the decimal point one place toward the left for every cipher in the divisor.

Thus,	And Thus,
10)768(.768	10)17.28(.1728
100)768(.0768	100)1.728(.01728
1000)768(.00768	1000)17.28(.001728
10000)768(.000768	10000)17.28(.0001728

APPROXIMATES.

In dividing approximates, the certain places of the quot may be determined by the following

RULE. Place the divisor under the first dividend, and the number of certain figures in the quot shall be one less than the number of places from the left of the divisor to the first + or —, whether in the divisor or in the dividend.

Ex. 1.	Ex. 2.
Dividend 1110.79286078—	Dividend 1110.7929—
Divisor 42.9723+	Divisor 25.8490136+
Certain places five, where- of three are decimals.	Certain places six, where- of four are decimals.

But here it is to be observed, that the uncertain car-

riage may, in some cases, effect several columns on the left, and thereby render more figures of the quot uncertain than the rule prescribes. The surest way, therefore, is, to make two operations with contrary signs, and then the figures in which the two quots agree are certain.

In order to make the reason of the rule appear, it will be necessary to work an example.

Example.

$$\begin{array}{r} \text{A} \\ 42.9723+)1110.79286078-(25.849 \\ \underline{859446} \phantom{0000} \\ 2513468 \\ \underline{2148615} \\ 3648536 \\ \underline{3437784} \\ 2107520 \\ \underline{1718892} \\ 3886287 \\ \underline{3867507} \\ 18780 \\ \text{B} \end{array}$$

Here we stop, no more places being certain. The reason is obvious; for the right-hand figure of the first product, viz, 6, is uncertain; and consequently all the figures under it, on the right of the line A B, will be so too; that is, the last remainder and new dividend are uncertain, and of course the figure that would go next to the quot.

From this example it appears, that all the figures on the right of the line A. B are uncertain and useless; if therefore a way of working, without writing down these useless figures, can be found, we shall then have a method of dividing long decimals, whether finite or approximate, so as to contract the operation, and limit the product to any number of decimal places proposed. And this may be effected by observing the following

RULE. Write the product of the first quotient-figure under the dividend; and from the situation of the units place, consider how many figures of the dividend must be retained to give the quot the number of decimal places intended; cut off the other figures on the right, and also the figures corresponding to them on the right of the divisor; then subtract; esteem this and every following remainder a new dividend; and for each new dividend drop a figure on the right of the divisor; but in multiplying the quotient-figures into the divisor, take in the carriage from the right hand; as in the following examples.

Ex. I. Divide 95.432756463275 by 3.4637528; and limit the quot to four decimal places.

Contracted.

Contracted by the rule.

$$3.46375(28)95.4327(56)463275(27.5518) \\ \dots\dots 6.92750(56)$$

$$\begin{array}{r} 261577 \\ 242462 \\ \hline 19115 \\ 17318 \\ \hline 1797 \\ 1731 \\ \hline 66 \\ 34 \\ \hline 32 \\ 27 \\ \hline (5) \end{array}$$

In the above example the units of the first product standing under the place of tens, the first figure of the quot is tens; and hence it is easy to foresee, that six figures of the dividend retained will give four decimal places to the quot; and accordingly cut off all the other figures on the right of the dividend; cut off likewise from the divisor two figures that correspond to them.

At every new dividual, drop or omit a figure on the right of the divisor, and mark the figure so dropped by setting a point under it; and in multiplying the quotient-figure 7 into the divisor, say, 7 times 7 is 49, and 3 of carriage from the right, (arising from  $7 \times 5 = 35$ ), makes 52; so set down 2, and carry 5. The same method is observed in multiplying every other quotient-figure into the divisor.

The same Example at large.

$$A \\ 3.46375(28)95.4327(56)463275(27.55183) \\ 6.92750(56) \dots\dots$$

$$\begin{array}{r} 261577004 \\ 242462696 \\ \hline 191143086 \\ 173187640 \\ \hline 179554463 \\ 173187640 \\ \hline 63668232 \\ 34637528 \\ \hline 290307047 \\ 277100224 \\ \hline 132068235 \\ 103912588 \\ \hline 129055647 \\ B \end{array}$$

In working the same example at large, the line A B shows how far the operation is contracted, and how much labour is saved.

But here observe, that by the rule for approximates the certain places of the quot are no more than five; viz. 27.551. And therefore, in all operations of this kind, care should be taken to limit the quot to so many places certain; as is done in the following example.

EXAMP. II. Divide 87.0763264525 by 9.365407024; limiting the quot to four decimal places certain.

$$9.36540(7024)87.07632(64525)(9.2976) \\ \dots\dots 84.28860(3216)$$

$$\begin{array}{r} 278766 \\ 187308 \\ \hline 91458 \\ 84288 \\ \hline 7170 \\ 6555 \\ \hline 615 \\ 561 \\ \hline 54 \end{array}$$

Here we put a stop to the operation; because, by the rule for approximates, the next figure of the quot would be uncertain.

We shall conclude division of finite decimals with two very useful problems.

PROB. I. From a given multiplier to find a divisor that gives a quot equal to the product.

RULE. Divide an unit with ciphers annexed by the given multiplier, and the quot will be the divisor sought.

EXAMP. What divisor will give a quot equal to the product of 125 into the dividend?

Given multiplier 125) 1.000(.008 divisor sought.

Now, if any number be divided by .008, and the same number be multiplied by 125, the quot and product will be equal.

$$.008)7315.000(914375 \text{ quot.} \\ 72 \dots\dots$$

$$\begin{array}{r} 11 \\ 8 \\ \hline 35 \\ 32 \\ \hline 30 \\ 24 \\ \hline 60 \\ 56 \\ \hline 40 \\ 40 \end{array} \qquad \begin{array}{r} 7315 \\ 125 \\ \hline 36575 \\ 14630 \\ 7315 \\ \hline 914375 \text{ product.} \end{array}$$

The reason is plain: for an unit contains the quot .008 just 125 times; and consequently .008 dividing any number

ber will give a quot 125 times greater than the dividend; that is, the quot will be equal to the product of the dividend multiplied by 125.

PROB. II. From a given divisor to find a multiplier that gives a product equal to the quot.

RULE. Divide an unit with ciphers annexed by the given divisor, and the quot will be the multiplier sought.

EXAMP. What multiplier will give a product equal to the quot arising from the same number divided by .008?

Given divisor .008)1.000(125 multiplier sought.

$$\begin{array}{r} 8 \cdot \cdot \\ \hline 20 \\ 16 \\ \hline 40 \\ 40 \end{array}$$

Now, if any number be multiplied by 125, and the same number be divided by .008, the product and quot will be equal; as appears in the example following.

$\begin{array}{r} 785 \\ 125 \\ \hline 3925 \\ 1570 \\ 785 \\ \hline 98125 \text{ product} \end{array}$	$\begin{array}{r} .008)785.000(98125 \text{ quot.} \\ 72 \\ \hline 65 \\ 64 \\ \hline 10 \\ 8 \\ \hline 20 \\ 16 \\ \hline 40 \\ 40 \end{array}$
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RULE II. If a finite divisor divide a repeating dividend, work as in integers; but in continuing the division, instead of annexing ciphers to the remainder, annex the repeating figure of the dividend.

<p>Ex. 1.</p> $\begin{array}{r} 5)83(.08 \\ 30 \\ \hline *3 \end{array}$	<p>Ex. 2.</p> $\begin{array}{r} 4)5.18(1.2918 \\ 4 \\ \hline 11 \\ 8 \\ \hline 36 \\ 36 \\ \hline 6 \\ 4 \\ \hline 26 \\ 24 \\ \hline *2 \end{array}$
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RULE III. If a finite divisor divide a circulating dividend, work as in integers; but in continuing the division, instead of annexing ciphers to the remainder, annex the circulating figures of the dividend.

Ex. 1.

$$\begin{array}{r} 7)3.370(.481,481, \\ 28 \cdot \cdot \\ \hline 57 \\ 56 \\ \hline 10 \\ 7 \\ \hline *33 \\ 28 \\ \hline 57 \\ 56 \\ \hline 10 \\ 7 \\ \hline *3 \end{array}$$

Ex. 2.

$$\begin{array}{r} .5)3.7,592,(7.518,5 \\ 3.5 \cdot \cdot \cdot \cdot 5 \\ \hline *25 \quad 3,7,592, \text{ proof.} \\ 25 \\ \hline 9 \\ 5 \\ \hline 42 \\ 40 \\ \hline *25 \end{array}$$

RULE IV. If the divisor be interminate, reduce it to a vulgar fraction, as taught in reduction of decimals, Prob. V.; then multiply the given dividend by the denominator, and divide the product by the numerator.

Here there are six cases; for the divisor may either repeat or circulate, and may divide a finite, a repeating, or circulating dividend.

CASE I. When a repeating divisor divides a finite dividend.

EXAMP. Divide 23.5 by  $.4 = \frac{2}{5}$

$$\begin{array}{r} 9 \\ \hline 4)211.5(52.875 \\ 20 \\ \hline 11 \\ 8 \\ \hline 35 \\ 32 \\ \hline 30 \\ 28 \\ \hline 20 \\ 20 \end{array}$$

CASE II. When a repeating divisor divides a repeating dividend.

EXAMP. Divide 43.28 by  $.3 = \frac{1}{3}$

$\begin{array}{r} 43.28 \\ 9 \\ \hline 3)389.40(129.8 \\ 3 \cdot \cdot \cdot \text{quot.} \\ \hline 8 \\ 6 \\ \hline 29 \\ 27 \\ \hline 24 \\ 24 \end{array}$	<p>Or rather thus:</p> $\begin{array}{r} 432.86 \\ 43.28 \\ \hline 3)389.40(129.8 \end{array}$
---	--

A R I T H M E T I C K.

CASE III. When a repeating divisor divides a circulate.

EXAMP. Divide 92.518, by  $.4 = \frac{4}{10}$ .  
 Or rather thus:  $925.185,$   
 $92.518,$   
 $\underline{9}$   
 832.666  
 $\underline{4)832.666(208.1\bar{6}}$   
 $8 \dots \dots$   
 $\underline{\quad}$   
 32  
 $\underline{32}$   
 $\underline{\quad}$   
 6  
 $\underline{4}$   
 $\underline{\quad}$   
 26  
 $\underline{24}$   
 $\underline{\quad}$   
 \*2

CASE IV. When a circulate divides a finite dividend.

EXAMP. Divide 9 by  $.45 = \frac{45}{100}$ .  
 In order to multiply the dividend 9 by 99, first multiply it by 100, which is done by annexing two ciphers; and from this product subtract the dividend.  
 $900$   
 $\underline{9}$   
 45)891(19.8.  
 $45 \cdot$   
 $\underline{\quad}$   
 441  
 $405$   
 $\underline{\quad}$   
 360  
 $360$

CASE V. When a circulate divides a repeating dividend.

EXAMP. Divide 5.83 by  $.72 = \frac{72}{100}$ .  
 $583.33$   
 $5.83$   
 $\underline{\quad}$   
 72)577.50(8.02083  
 $576$   
 $\underline{\quad}$   
 150  
 $144$   
 $\underline{\quad}$   
 600  
 $576$   
 $\underline{\quad}$   
 240  
 $216$   
 $\underline{\quad}$   
 \*24

CASE VI. When a circulate divides a circulate.

EXAMP. Divide .962, by  $.18 = \frac{18}{100}$

$$\begin{array}{r} .962, \\ \underline{.962,} \\ 18)95.333(5.296, \\ 90 \dots \dots \\ \underline{\quad} \\ *53 \\ \underline{36} \\ \underline{\quad} \\ 173 \\ \underline{162} \\ \underline{\quad} \\ 113 \\ \underline{108} \\ \underline{\quad} \\ *5 \end{array}$$

When the circle of the quot is likely to run on to many places, you may stop the operation, and complete the quot by a vulgar fraction; as in the following example.

EXAMP. Divide 34.56097, by 3.592, =  $\frac{3456097}{3592}$

$$\begin{array}{r} 3.592, ) 34560.97560, \\ \underline{3 \quad 34.56097,} \\ 3589) 34526.41463, (9.6200653 \frac{272446145}{99999} \\ \underline{32301 \dots \dots} \\ 22254 \\ \underline{21534} \\ \underline{\quad} \\ 7201 \text{ Or, } 9.6200653 \frac{272446145}{99999} \\ \underline{7178} \end{array}$$

The quot would run on to 49 figures of a finite part, and then a circle of 65 places; but limit it at seven places of decimals, and then complete it by a vulgar fraction; as follows, viz. (2724)

Complete the partial remainder 2724 by annexing to it the circle of the dividend, and placing both, by way of numerator, over the divisor 3589.

The numerator of this complex fraction being a mixt number, reduce it to an improper fraction, by multiplying 2724 by the denominator 99999, and adding the numerator 46341 to the product; as in the margin: and then, instead of the mixt number, the numerator of the complex fraction will be  $\frac{272446341}{99999}$ . Or rather work thus: Esteem 2724.46341, a circulate; and then you find the numerator of the vulgar fraction by subtracting the finite part.



Next divide this fractional numerator by the denominator; which is done by multiplying 3589 by 99999, as in the margin; and now the simple vulgar fraction to be annexed to the partial quot is  $\frac{358900000}{358896411}$ .

If the quot thus completed be multiplied by the divisor, it will produce the dividend.

VII. *Decimal Practice.*

THE price of goods or merchandise may be cast up decimally by any of the methods following.

METHOD I. Find the decimal of the rate, viz. the value of one yard, one pound, one piece, &c.; and this decimal of the rate multiplied into the number or quantity of the goods gives the price.

Ex. 1. At 3 s. 4 d. what cost 346?

The decimal of the  
rate is  $.1\beta = \frac{1}{5}$

L. s. d.

5|0)519|0(57.β = 57 13 4.

45

---

69

63

---

60

54

---

26

Ex. 2. At 6 s. 8 d. what cost 439?

The decimal of the rate is  $\beta$  L. s. d.  
 $3)439(146.3 = 146 6 8$

METHOD II. When the rate consists of pence and farthings, find how often it is contained in one pound Sterling, divide the given number of goods by this number, or by its component parts, or work by aliquot parts, and the result will be the price sought.

We confine this method to such rates as consist of pence and farthings, because when the rate consists of shillings, pence, and farthings, or of pounds, shillings, pence, &c. it is shorter and easier to work by Method I.

To make the practice ready and easy, it will be proper to have at hand a table of rates and divisors, such as the following one.

TABLE OF RATES and DIVISORS.

Rates.	0 Farth.	1 Farth.	2 Farth.	3 Farth.
d.	Divif.	Divif.	Divif.	Divif.
0		3,8,40.	8,60.	8,40.
1	6,40.	8,6,4.	4,40.	4,30,—8.
2	4,30.	4,30,+8.	4,30,+4.	80,—12.
3	80.	80,+12.	80,+6.	80,+4.
4	60.	60,+4 of 4.	60+8.	60+8+2 of 8.
5	6,8.	40,—8.	40—12.	40—4 of 6.
6	40.	40+4 of 6.	40+12.	40+8.
7	40+6.	40+6+4 of 6.	40+4.	40+4+6 of 4.
8	30.	30+4 of 8.	30+2 of 8.	80,×3,—12 of 80.
9	80,×3.	80,×3,+12 of 80.	80,×3,+6 of 80.	80,×3,+4 of 80.
10	8,3.	30,+4,+8 of 4.	20,—8.	40,+2,+2,+6.
11	20,—12.	40,×2,—8 of 40.	40,×2,—12 of 40.	8,3,+5,—8 of 5.

In the above table the pence stand in the left-hand column, and the farthings on the head, and the divisors in the angle of meeting; which are to be understood and read as follows.

3,8,40. Divide the given number of goods by 3, divide the quot by 8, and again divide this last quot by 40.

4,30,—8. Divide the number of goods by 4, divide the quot by 30, and from this last quot subtract one 8th of itself.

80+12. To an 80th add a 12th of that 80th.

4,30,+4. To a 30th of a 4th add a 4th of that 30th.

60,.

60, +4 of 4, Divide by 60, divide again the quot by 4, and to the first quot add a 4th of the second quot.  
 80x3, —12 of 80. Divide by 80, multiply the quot by 3, and from the product subtract a 12th of the first quot.

Ex. 1. At 1 f. per yard, what cost 432 yards?

One 3d = 144  
 One 8th of that = 18  
 One 40th of that = .45 = 9s.

Ex. 2. At 3 f. what cost 728.5?

One 8th = 91.0625 L. s. d.  
 One 40th of that = 2.2765625 = 2 5 6½  
 METH. III. The third method is by decimal tables of rates suited to the nine digits; such as those composed and published by the Rev. Mr George Brown in 1718, under the title of *Arithmetica Infinita*, and recommended by Dr John Keill professor of astronomy in the university of Oxford.

These tables are still extant, and extend from 1 farthing to 20s.; a short specimen of which, with their construction, and the manner of using them, we shall here subjoin.

Decimal Table of Rates, 1 l. the integer.

N.	Rate.	Rate.	Rate.	Rate.
	s. d.	s. d.	s. d.	s. d.
	11 5	11 5½	11 5½	11 5½
1	0.57083	0.571875	0.572916	0.5739583
2	1.1416	1.14375	1.14583	1.147916
3	1.7125	1.715625	1.71875	1.721875
4	2.283	2.2875	2.2916	2.29583
5	2.85416	2.859375	2.864583	2.8697916
6	3.425	3.43125	3.4375	3.44375
7	3.99583	4.003125	4.010416	4.0177083
8	4.56	4.575	4.583	4.5916
9	5.1375	5.146875	5.15625	5.165625

In the left-hand column stand the nine digits; and on the right of 1 are the decimals of the respective rates on the head. Thus, .57083 is the decimal of 11 s. 5d. one pound being the integer; and .571875 is the decimal of 11 s. 5½d. &c. Those decimals opposite to 1 being multiplied through the nine digits, make up or compose the rest of the table.

The superior excellency of tables thus constructed is, that we multiply or divide by 10, 100, 1000, &c. by moving the decimal point so many places to the right or left as there are ciphers in the multiplier or divisor.

Hence the price or value of any number of yards, or other things, denoted by a single digit, or by any of its decuples, may be readily found. Thus, the price of 7, 70, 700, 7000, 70000, 700000 yards, at 11 s. 5d. per yard, is found as follows.

Yards.	L.	L. s. d.
7 =	3.99583 =	3 19 11
70 =	39.9583 =	39 19 2
700 =	399.583 =	399 11 8
7000 =	3995.83 =	3995 16 8
70000 =	39958.3 =	39958 6 8
700000 =	399583.3 =	399583 6 8

Now, every number may be resolved into decuples of the several digits of which it is composed; find therefore the price of each decuple by itself, as already taught, and their sum will be the price of the whole.

EXAMP. I. Required the price of 7956 yards, at 11 s. 5½d. per yard.

Yards.	L.	L. s. d.
7000 =	4017.708333	
900 =	516.5625	
50 =	28.697916	
6 =	3.44375	
	4566.412500 =	4566 8 3

EXAMP. 2. How much money will one spend in a year, or 365 days, at the rate of 11 s. 5½d. per day?

Days.	L.	L. s. d.
300 =	171.875	
60 =	34.375	
5 =	2.864583	
	209.114583 =	209 2 3½

Tables of this sort may be framed for a great variety of useful purposes, and are easily constructed.

Thus, suppose a table wanted for showing the daily income of any annuity, or yearly pension; in this case, divide 1 by 365, and the quot is the income of 1 l. annuity for one day; and by multiplying this quot through the nine digits, the table is constructed as follows.

TABLE.	
1.	0.02739726,
2.	0.05479452,
3.	0.08219178,
4.	0.10958904,
5.	0.13698630,
6.	0.16438356,
7.	0.19178082,
8.	0.21917808,
9.	0.24657534,

The use of the table will best appear by examples; which take as follows.

Example 1.

If one has a yearly pension of 375 l. what is his daily income?

L.	L. s. d.
300 =	.8219
70 =	.1917
5 =	.0136
	1.0272 =
	1 0 6½

Example 2.

The yearly rent of a gentleman's estate is 968 l. 10 s. what can he afford to spend per day?

L. 900

L.  
 900 = 2.4657  
 60 = .1643  
 8 = .0219  
 0.5 = .0013

---

L. s. d.  
 2.6532 = 2 13 0 $\frac{1}{2}$

If the income for any number of days be required, find the income for one day as above; and multiply the decimal answer by the given number of days. Or, multiply the yearly pension by the given number of days, and use the product as the yearly pension. Thus, in Ex. 2. if the gentleman's income for 64 days be demanded, you may either multiply 2.6532 by 64; or multiply 968.5 by 64; and then work for the product as follows.

968.5	60000 = 164.3835
64	1000 = 2.7397
<hr/>	900 = 2.4657
38740	80 = .2191
58110	4 = .0109
	<hr/>
61984.0	L. s. d.
	169.8189 = 169 16 4 $\frac{1}{2}$

The decimals in the table being circles of eight figures; we have used them as approximates, by confining the operations to four decimal places; which, in affairs of this kind, is sufficiently accurate.

If the annual interest of any principal sum be considered as the yearly pension, the interest of the same principal for any number of days may be found by the table as taught above.

The interest of any principal sum for a year is easily found, as being always the hundredth part of the product of the principal multiplied by the rate *per cent.*

EXAMP. Required the interest for 26 days of 685 l. principal, at 5 *per cent.*

L.	
685	
5	
<hr/>	
34.25 annual interest.	
26	
<hr/>	
20550	800 = 2.19178
6850	90 = .24657
	0.5 = .00136
	<hr/>
890.50	L. s. d.
	2.43971 = 2 8 9 $\frac{1}{2}$

DUODECIMALS.

Decimal practice may be used with great advantage in the multiplication and division of duodecimals, where the integer is divided into twelve equal parts, called *primes*, and each prime into twelve seconds, each second into twelve thirds, &c.

For the ready conversion of primes, seconds, thirds, &c. into decimals of the integer, the following table is constructed.

Decimal table of primes, seconds, &c.

N.	Primes.	Seconds.	Thirds.	Fourths.
	'	"	'''	''''
1	.083	.00694	.000578,703	.00004822
2	.16	.0138	.001157,407	.00009645
3	.25	.02083	.001736,111	.00014467
4	.3	.027	.002314,814	.00019290
5	.416	.03472	.002893,518	.00024112
6	.5	.0416	.003472,222	.00028935
7	.583	.0486	.004050,925	.00033757
8	.6	.05	.004629,629	.00038580
9	.75	.0625	.005208,333	.00043402
10	.83	.0694	.005787,037	.00048215
11	.916	.07638	.006365,740	.00053047

In the column of fourths, the decimals run on to eight places of a finite part, and nine figures of a circle; but the finite part by itself, which alone is inserted in the table, will be found sufficient; and in the column of thirds too, the circle of three figures may in most cases be neglected.

I. Multiplication.

Example 1.

What is the product of 247 by 18 5

24 7 = 24.583  
 18 5 = 18.416 = 18 $\frac{5}{12}$

Or thus:

24.583	24.58333
16575	14.81
<hr/>	<hr/>
122916	2458333
1720833	1966666
12291666	98333
147500000	2458
245833333	<hr/>
9 00) 407468.750	452.5790
	$\frac{1}{12}$ = 819
	$\frac{1}{12}$ = 819
	<hr/>
452.74303	452.7428
12	12
<hr/>	<hr/>
8.91666	8.9136
12	12
<hr/>	<hr/>
11.000	10.9632
' "	

Ans. 452 8 11

In working by the inverted method, for the repeating 6 in the multiplier, take  $\frac{2}{3}$  of the multiplicand. The result wants very little of the true answer.

*Examp. 2.*

Multiply 18 6 by 2 4, and 2 3 continually.

$\begin{array}{r} 18\ 6 = 18.5 \\ 2\ 4 = 2.3 \\ 2\ 3 = 2.25 \end{array}$	$\begin{array}{r} 2.3 \\ 18.5 \\ \hline 116 \\ 1866 \\ 2333 \\ \hline 43.16 \\ 2.25 \\ \hline 21583 \\ 86333 \\ 863333 \\ \hline 97.1250 \\ 12 \end{array}$
--	---

*Ans. 97 1 6*

$\begin{array}{r} 1.500 \\ 12 \\ \hline 6.0 \end{array}$	
--	--

II. *Division.*

*Examp. 1.*

$\begin{array}{r} \text{Divide } 452\ 8\ 11 = 452.74308 \\ \text{by } 18\ 5 = 18.416 = \frac{6575}{360} \\ \hline 18.416)4527.43085 \\ 1841\ 452.74308 \\ \hline 16575)407468.750(24.583 \\ 33150 \dots 12 \\ \hline 75968 \quad 7.000 \\ 66300 \\ \hline 96687 \\ 82875 \\ \hline 138125 \\ 132600 \\ \hline 55250 \\ 49725 \\ \hline *5525 \end{array}$	<p style="text-align: right; margin-right: 20px;"><i>Ans. 24 7</i></p>
---	--

*Examp. 2.*

$\begin{array}{r} \text{Divide } 97\ 1\ 6 = 97.125 \\ \text{by } 2\ 3 = 2.25 \text{ and the quot} \\ \text{by } 18\ 6 = 18.5 \\ \hline 18.5) \\ 2.25)97.125(43.16(2.3 \\ 900 \dots 370 \quad 12 \\ \hline 712 \quad 616 \quad 4.0 \\ 675 \quad 555 \\ \hline 375 \quad *61 \\ 225 \\ \hline 1500 \\ 1350 \quad \text{Ans. } 2\ 4 \\ \hline *150 \end{array}$	
--	--

SEXAGESIMALS.

Decimal practice might likewise be used to good purpose in the arithmetic of sexagesimals, as it would shorten and facilitate the operations.

Sexagesimals, strictly speaking, are degrees, minutes, seconds, thirds, &c. where each degree is divided into 60 minutes, and each minute into 60 seconds, &c.; but under this title is also usually comprehended the division of a sign into 30 degrees. They are commonly marked as under.

*Signs. deg. min. sec. thirds.*

7 24 36 54 48 &c.

Sexagesimals properly belong to astronomy, being used in computations of motion and time, where the degree of motion, and hour of time, are equally divided into 60 minutes. The preference of the decimal method to that of the sexagesimal will appear from the following example of addition done both ways.

<i>Sexagesimally.</i>	<i>Decimally.</i>
<i>Signs.</i>	<i>S.</i>
10 20 47 17 = 10.69293,518,	
7 18 50 40 = 7.62814,814.	
9 25 30 28 = 9.85018,518,	
11 10 40 50 = 11.35601,851,	

3 15 49 7 = 3.52728,703,

From the above example it is obvious, that even in addition the decimal operation is more simple and easy than the sexagesimal, especially if care be taken to use no more decimal places than what are absolutely necessary.

But in multiplication and division the advantage of the decimal method is still greater; for in the sexagesimal way the operation is extremely tedious; whereas, by working decimally, it is performed in the same manner, and with the same ease, as in duodecimals.

VULGAR FRACTIONS.

Decimal practice may sometimes be profitably used in the

the arithmetic of vulgar fractions, the operation being shorter and easier in the decimal than in the vulgar way. This we shall illustrate by a few examples.

I. Addition.

Ex. 1. What is the sum of  $\frac{1}{2} + \frac{2}{3} l.$ ?

$$\begin{array}{r} \frac{1}{2} = .25 \\ \frac{2}{3} = .666 \\ \hline .916 = 18 \text{ s. } 4 \text{ d.} \end{array}$$

Ex. 2. What is the sum of  $14\frac{1}{2} + 18\frac{2}{3} + \frac{1}{4}$  of  $\frac{1}{2}$  C.?

$$\begin{array}{r} C. \\ 14\frac{1}{2} = 14.875 \\ 18\frac{2}{3} = 18.666 \\ \frac{1}{4} \text{ of } \frac{1}{2} = \frac{1}{8} = .125 \\ \hline 34.666 = 34 \text{ C. } 2 \text{ lb. } 18\frac{2}{3} \end{array}$$

II. Subtraction.

Ex. 1. From  $\frac{3}{4}$  subtract  $\frac{1}{3} l.$

$$\begin{array}{r} L. \\ \frac{3}{4} = .75 \\ \frac{1}{3} = .333 \\ \hline .416 = 8 \text{ s. } 4 \text{ d.} \end{array}$$

Ex. 2. From  $\frac{2}{3}$  of  $\frac{1}{2}$  subtract  $\frac{1}{4}$  of  $\frac{1}{2}$  lb. Troy.

$$\begin{array}{r} lb. \\ \frac{2}{3} \text{ of } \frac{1}{2} = \frac{1}{3} = .333 \\ \frac{1}{4} \text{ of } \frac{1}{2} = \frac{1}{8} = .125 \\ \hline .208 = 5 \text{ oz. } 10 \text{ dw.} \end{array}$$

III. Multiplication.

Ex. Multiply  $19\frac{1}{2}$  by  $22\frac{1}{2}$  feet.

$$\begin{array}{r} F. \\ 19\frac{1}{2} \times 22\frac{1}{2} = 437.5 \\ \hline 19583 \\ 391666 \\ \hline 9)3936.250 \\ \hline 437.367 = 437 \text{ Sq.f. } 36 \text{ sq.in.} \end{array}$$

II. Division.

Ex. Divide  $6\frac{1}{2}$  by  $\frac{1}{4}$ .

$$\begin{array}{r} \frac{1}{4} = .25 \\ \frac{1}{2} = .50 \\ \hline .75 = 17 \text{ s. } 6 \text{ d.} \end{array}$$

$$\begin{array}{r} 272 \\ 252 \\ \hline 205 \\ 180 \\ \hline 250 \\ 216 \\ \hline 340 \\ 324 \\ \hline 160 \\ 144 \\ \hline *16. \end{array}$$

Rule of Three Direct.

DECIMAL practice is frequently the shortest and easiest method of operation in the rule of three.

EXAMP. I. If C. 3: 1: 14 of raisins cost L. 10: 2: 6, what will 6. C. 3 Q. cost at that rate?

$$\begin{array}{r} C. \text{ Q. } L. \text{ s. } d. \text{ C. } Q. \\ \text{Vulgar state } 3 \text{ } 1 \text{ } 14 \text{ } 10 \text{ } 2 \text{ } 6 \text{ } :: 6 \text{ } 3 \\ \text{Decimal state } 3.375 \text{ } : 10.125 \text{ } :: 6.75 \end{array}$$

$$\begin{array}{r} 50625 \\ 70875 \\ 60750 \\ \hline 3.375)68.34375(20.25 = 20 \text{ } 5 \\ \hline 6750 \dots \\ \hline 8437 \\ 6750 \\ \hline 16875 \\ 16875 \end{array}$$

EXAMP. II. If a wedge of gold, weighing 14 lb: 3. oz. 8 dw. cost L. 514, 4 s. what is that per ounce?

Vulgar:

16. oz. dw. L. s. oz.  
 Vulgar state 14 3 8 : 514 4 :: 1  
 Decimal state 14.283 : 514.2 :: .083

514.2  
 160  
 1333  
 8333  
 416666  
 14.283)42.8500(  
 1428 42.850  
 ----- L.  
 12855)38565-0(3 Ans.  
 38565

Rule of Three Inverse.

EXAMP. If you borrow L. 64 for 8 months, what sum lent for 12 months, or a year, will requite the favour?

r. L. r.  
 Vulgar state 1 : 64 :: r.  
 Decimal state 1 : 64 :: .08

6  
 ----- L. s. d.  
 9)384(42.8=42 13 4  
 36

24  
 18 Or thus:  
 -----  
 60 3)64(21.3  
 34 21.3

\*6 The same 42.8 as before.

Compound Rule of Three.

EXAMP. What is the interest of L. 75 : 10 : 4 for 8 months, at the rate of 5 per cent. per annum?

M. L. L. s. d. M.  
 Vulgar state 12 x 100 : 5 :: 75 10 4 x 8  
 Decimal state 12 x 100 : 5 :: 75.516 x 8  
 12 8

1200 : 5 :: 604.133  
 5

12)100)3020.666(  
 ----- L. s. d.  
 2.5177 = 2 10 4

The simple separate operations of the same example follow.

L. L. L.  
 100 : 5 :: 75.516  
 5

M. L. M.  
 12 : 3.77583 :: 8  
 8

1)100)377.583(  
 -----  
 3.77583

12)30.20666(  
 -----  
 2.5177 Ans.

If unity be multiplied continually by any given number, the products thence arising are called *powers of that number*; and the given number is called *the root, or first power*.

Thus, if 2 be the given number, then 1x2=2 is the root or first power; and 2x2=4 is the square or second power; and 4x2=8 is the cube or third power; and 8x2=16 is the biquadrate or fourth power; and 16x2=32 is the sursolid or fifth power; and 32x2=64 is the sixth power, or cube squared, &c.

The natural numbers, 1, 2, 3, &c. are sometimes placed over these powers, denoting the number of multiplications used in producing them, or showing what powers they are; and are called *indices or exponents*, as in the following scheme.

Indices, 1, 2, 3, 4, 5, 6, 7, &c.  
 Powers, 1, 2, 4, 8, 16, 32, 64, 128, &c.

The raising any root or number given to any power required, is called *involution*; and is performed by multiplying the given root into unity continually, as taught above. But the finding the root of a given power is called *evolution, or extraction of roots*.

If the root of any power not exceeding the seventh power, be a single digit, it may be obtained by inspection, from the following table of powers.

T A B L E.

1st power or root.	2d power or square.	3d power or cube.	4th power or biquadrate.	5th power or sursolid.	6th power or cube squared.	7th power.
1	1	1	1	1	1	1
2	4	8	16	32	64	128
3	9	27	81	243	729	2187
4	16	64	256	1024	4096	16384
5	25	125	625	3125	15625	78125
6	36	216	1296	7776	46656	279936
7	49	343	2401	16807	117649	823543
8	64	512	4096	32768	262144	2097152
9	81	729	6561	59049	531441	4782969

I. Extraction of the Square Root.

RULE I. Divide the given number into periods of two figures, beginning at the right hand in integers, and pointing toward the left. But in decimals, begin at the place of hundreds, and point toward the right. Every period will give one figure in the root.

II. Find by the table of powers, or by trial, the nearest lesser root of the left-hand period, place the figure so found in the quot, subtract its square from the said period, and to the remainder bring down the next period for a dividend or resolvend.

III. Double the quot for the first part of the divisor; inquire how often this first part is contained in the whole resolvend, excluding the units place; and place the figure denoting the answer both in the quot and on the

the right of the first part; and you have the divisor complete.

IV. Multiply the divisor thus completed by the figure put in the quot, subtract the product from the resolvend, and to the remainder bring down the following period for a new resolvend, and then proceed as before.

Note 1. If the first part of the divisor, with unity supposed to be annexed to it, happen to be greater than the resolvend, in this case place 0 in the quot, and also on the right of the partial divisor; to the resolvend bring down another period; and proceed to divide as before.

Note 2. If the product of the quotient-figure into the divisor happen to be greater than the resolvend, you must go back, and give a lesser figure to the quot.

Note 3. If, after every period of the given number is brought down, there happen at last to be a remainder, you may continue the operation, by annexing periods or pairs of ciphers, till there be no remainder, or till the decimal part of the quot repeat or circulate, or till you think proper to limit it.

EXAMP. I. Required the square root of 133225.

Square number	133225(365 root	365	
	9	365	
<hr/>			
1 div. 66)	432 resolvend.	1825	
	396 product.	2190	
<hr/>			
2 div. 725)	3625 resolvend.	1095	
	3625 product.	133225 proof.	

EXAMP. II. Required the square root of 72, to eight decimal places.

72.00000000(8.48528137 root.  
64

164)	800	656	
<hr/>			
1688)	14400	13504	
<hr/>			
16965)	89600	84825	
<hr/>			
169702)	477500	339404	
<hr/>			
169704)	138096	135763	
<hr/>			
	2333	1697	
<hr/>			
	636	509	
<hr/>			
	127	118	
<hr/>			

After getting half of the decimal places, work by contracted division for the other half; and obtain them with the same accuracy as if the work had been at large.

EXAMP. III. Required the square root of .2916.

	.2916(.54 root.	25	
<hr/>			
104)	416	416	
<hr/>			

If the square root of a vulgar fraction be required, find the root of the given numerator for a new numerator, and find the root of the given denominator for a new denominator. Thus, the square root of  $\frac{4}{9}$  is  $\frac{2}{3}$ , and the root of  $\frac{16}{49}$  is  $\frac{4}{7}$ ; and thus the root of  $\frac{25}{4}$  ( $=6\frac{1}{4}$ ) is  $\frac{5}{2} = 2\frac{1}{2}$ .

But if the root of either the numerator or denominator cannot be extracted without a remainder, reduce the vulgar fraction to a decimal, and then extract the root, as in Example III. above.

II. Extraction of the Cube Root.

RULE I. Divide the given number into periods of three figures, beginning at the right hand in integers, and pointing toward the left. But in decimals, begin at the place of thousands, and point toward the right. The number of periods shews the number of figures in the root.

II. Find by the table of powers, or by trial, the nearest lesser root of the left-hand period; place the figure so found in the quot; subtract its cube from the said period; and to the remainder bring down the next period for a dividend or resolvend.

The divisor consists of three parts which may be found as follows.

III. The first part of the divisor is found thus: Multiply the square of the quot by 3, and to the product annex two ciphers; then inquire how often this first part of the divisor is contained in the resolvend, and place the figure denoting the answer in the quot.

IV. Multiply the former quot by 3, and the product by the figure now put in the quot; to this last product annex a cipher; and you have the second part of the divisor. Again, square the figure now put in the quot for the third part of the divisor; place these three parts under one another, as in addition; and their sum will be the divisor complete.

V. Multiply the divisor, thus completed, by the figure last put in the quot, subtract the product from the resolvend, and to the remainder bring down the following period for a new resolvend, and then proceed as before.

Note 1. If the first part of the divisor happen to be equal to or greater than the resolvend, in this case place 0 in the quot, annex two ciphers to the said first part of the divisor, to the resolvend bring down another period, and proceed to divide as before.

Note 2. If the product of the quotient-figure into the divisor happen to be greater than the resolvend, you must go back, and give a lesser figure to the quot.

Note 3. If, after every period of the given number is brought down, there happen at last to be a remainder, you may continue the operation by annexing periods of three ciphers till there be no remainder, or till you have

as many decimal places in the root as you judge necessary.

EXAMP. I. Required the cube root of 12812904.

Cube number 12812904 (234 root  
8

1st part 1200 } )4812 resolvend,  
2d part 180 }  
3d part 9 }

1 divisor 1389 × 3 = 4167 product.

---

1st part 158700 } )645904 resolvend.  
2d part 2760 }  
3d part 16 }

2 divisor 161476 × 4 = 645904 product.

P R O O F.

234	Square 54756
234	234
936	219024
702	164268
468	109512
<hr/>	
Square 54756	Cube 12812904

EXAMP. II. Required the cube root of 28750000.

28.750000 (3.06 root.  
27

270000 } ) 1750000 resolv.  
5400 }  
36 }

Div. 275436 × 6 = 1652616 prod.  
97384 rem.

P R O O F.

3.06	Sq. 9.3636
3.06	3.06
1836	561816
918	280908
<hr/>	
Sq. 9.3636	28.652616
	97384 rem.
	28.750000 cube.

If the cube root of a vulgar fraction be required, find the cube root of the given numerator for a new numerator, and the cube root of the given denominator for a new denominator. Thus, the cube root of  $\frac{8}{27}$  is  $\frac{2}{3}$ , and the cube root of  $\frac{27}{125}$  is  $\frac{3}{5}$ ; and thus the cube root of  $\frac{8}{125}$  ( $= 15\frac{1}{4}$ ) is  $\frac{2}{5} = 2\frac{1}{4}$ .

But if the root of either the numerator or denomina-

tor cannot be extracted without a remainder, reduce the vulgar fraction to a decimal, and then extract the root.

III. Extraction of the Biquadrate Root.

RULE. Extract the square root of the given number; and again extract the square root of the root so found, and the last of these roots is the root sought.

EXAMP. Required the biquadrate root of 5308416.

5308416 (2304 (48 root.  
4 16

43)130 88)704  
129 704

4604) 18416  
18416

If, in the first extraction, there happen to be a remainder, continue the operations, by annexing pairs of ciphers, till you have twice as many decimal places in the square or first root, as you propose to have in the last root.

IV. Extraction of the root of the fifth power, or fursolid.

RULE I. Divide the given number into periods of five figures, find the nearest lesser root of the left-hand period, put the figure so found in the quot, subtract its fifth power, and to the remainder bring down the next period for a resolvend.

II. Put  $a+y$  for the root, and then the fursolid or fifth power will be  $aaaaa + 5aaaay + 10aaaayy + 10aayyy + 5ayyyy + yyyyy$ . Now,  $aaaaa$  being already subtracted, there remains the other five parts; and to find  $y$ , divide by its coefficient, viz. by  $5aaaa + 10aaaay + 10aayyy + 5ayyy + yyy$ ; that is, try how often  $5aaaa$  is contained in the resolvend; and, by the help of the quotient-figure, you make up the other four parts of the divisor.

EXAMP. Required the fursolid root of 33554432.

33554432 (32 root.  
243

) 9254432 resolv.  
4050000 = 5aaaa  
540000 = 10aaaay  
36000 = 10aayyy  
1200 = 5ayyy  
16 = yyy

Divisor 4627216 × 2 = 9254432 prod.

(0)

V. Extraction of the root of the sixth power, or cubo squared.

RULE. Extract the square root of the given number, and then extract the cube root of that root, the last is the



The root sought. Or, first extract the cube root, and then extract the square root of that root.

EXAMP. Required the root of 191102976, being the sixth power.

191102976 (13824(24 root.  
 1                      8  
 23) .91              1200)5824 resolv.  
   69                  240  
   —                  16  
 268)2210              —  
   2144              1456 × 4 = 5824 prod.  
 2762) 6629              (0)  
      5524  
 27644)110576  
      110576

VI. Extraction of the root of the seventh power.

RULE. Put  $a + y$  for the root, and the seventh power will be  $aaaaaaa + 7aaaaay + 21aaaaayy + 35aaaaayyy + 35aaaaayyy + 21aaaaayyy + 7aaaaayyy + yyyyyyy$ , by the aid of which proceed as in extracting the root of the fifth power.

EXAMP. Required the root of 3404825447, being the seventh power.

3404825447(23 root.  
 128  
 2)124825447 resolv.  
 448000000 = 7aaaaaa  
 201600000 = 21aaaaay  
 50400000 = 35aaaaayy  
 7560000 = 35aaaaayy  
 680400 = 21aaaaayy  
 34020 = 7aaaaayy  
 729 = yyyyyyy

Divid. 708275149 × 3 = 2124825447 prod.

(0)

VII. Extraction of the root of the eighth power.

RULE. Extract the square root of the given number.

continually till you have three roots; the last of these is the root sought.

Thus, let 1785793904896 be the eighth power; by extracting the square root you get the biquadrate or fourth power, viz. 1336336; and by extracting the square root of the biquadrate, you get the square or second power, viz. 1156, whose square root is 34, the root sought.

VIII. Extraction of the root of the ninth power.

RULE. Extract the cube root of the given number, and you have the cube or third power, whose cube root is the root sought.

Thus, let 5159780352 by the ninth power; by extracting the cube root you get the cube or third power, viz. 1728, whose cube root 12 is the root sought.

Universally, whatever the given power be, put  $a + y$  for the root, and by involution raise  $a + y$  to the power of the given number; then, with this as your guide or canon, extract the root in the manner prescribed and exemplified in the extraction of the root of the fifth and seventh powers.

But if the index of the given power be a multiple of 2, the work may be rendered easier: For, by extracting the square root of the given number, you obtain a power whose index is one half of the index of the given power. Thus, by extracting the square root of the tenth power, you have the fifth power; and the square root of the twelfth power is the sixth power, &c.

Again, if the index of the given power be a multiple of 3, by extracting the cube root you obtain a power whose index is one third of the index of the power given. Thus the cube root of the ninth power is the cube or third power; and the cube root of the twelfth power is the biquadrate or fourth power, &c.

Involution is directly contrary to extraction or evolution; and therefore, if a square number be squared, it will give the biquadrate or fourth power; and if a biquadrate be squared, it will give the eighth power. Again, if a cube number be cubed, it will give the ninth power; and if the biquadrate be cubed, it will give the twelfth power. See ALGEBRA, Chap. IX. and X.

For the application of Arithmetic to various branches of business, &c. see ALLIGATION, ANNUITIES; BARTER, BROKAGE, BANKRUPTCY, EXCHANGE, INSURANCE, INTEREST, MENSURATION, &c. &c.

A R K

A R K

ARITHMOMANCY, a species of divination performed by means of numbers.

ARK, or Noah's ARK, a floating vessel built by Noah, for the preservation of his family, and the several species of animals, during the deluge. See Plate XXXVIII. fig. 1.

The ark has afforded several points of curious inquiry among the critics and naturalists, relating to its form, capacity, materials, &c.

The wood whereof the ark was built, is called in the Hebrew Gopher-wood, and in the Septuagint square timbers. Some translate the original cedar, others pine, others:

others box, &c. Pelletier prefers cedar, on account of its incorruptibility, and the great plenty of it in Asia; whence Herodotus and Theophrastus relate, that the kings of Egypt and Syria built whole fleets thereof, instead of deal.

The learned Mr Fuller in his Miscellanies, has observed, that the wood whereof the ark was built, was nothing else but that which the Greek call *καραϊσσος*, or the *cypressi-tree*; for, taking away the termination, *καρα* and *gopher* differ very little in sound. This observation the great Bochart has confirmed, and shewn very plainly that no country abounds so much with this wood as that part of Assyria which lies about Babylon.

In what place Noah built and finished his ark is no less made a matter of disputation. But the most probable opinion is, that it was built in Chaldæa, in the territories of Babylon, where there was so great a quantity of cypress in the groves and gardens in Alexander's time, that that prince built a whole fleet out of it, for want of timber. And this conjecture is confirmed by the Chaldean tradition, which makes Xithurus (another name for Noah) set sail from that country.

The dimensions of the ark, as given by Moses, are 300 cubits in length, 50 in breadth, and 30 in height, which some have thought too scanty, considering the number of things it was to contain; and hence an argument has been drawn against the authority of the relation. To solve this difficulty many of the ancient fathers, and the modern critics, have been put to very miserable shifts: But Buteo and Kircher have proved geometrically, that, taking the common cubit of a foot and a half, the ark was abundantly sufficient for all the animals supposed to be lodged in it. Snellius computes the ark to have been above half an acre in area, and father Lamy shews, that it was 110 feet longer than the church of St Mary at Paris, and 64 feet narrower; and if so, it must have been longer than St Paul's church in London, from west to east; and broader than that church is high in the inside, and 54 feet of our measure in height; and Dr Arbuthnot computes it to have been 81062 tuns.

The things contained in it were, besides eight persons of Noah's family, one pair of every species of unclean animals, and seven pair of every species of clean animals, with provisions for them all during the whole year. The former appears, at first view, almost infinite; but if we come to a calculation, the number of species of animals will be found much less than is generally imagined, not amounting to an hundred species of quadrupeds, nor to two hundred of birds; out of which, in this case, are excepted such animals as can live in the water. Zoologists usually reckon but an hundred and seventy species in all; and bishop Wilkins shews that only seventy-two of the quadruped kind needed a place in the ark.

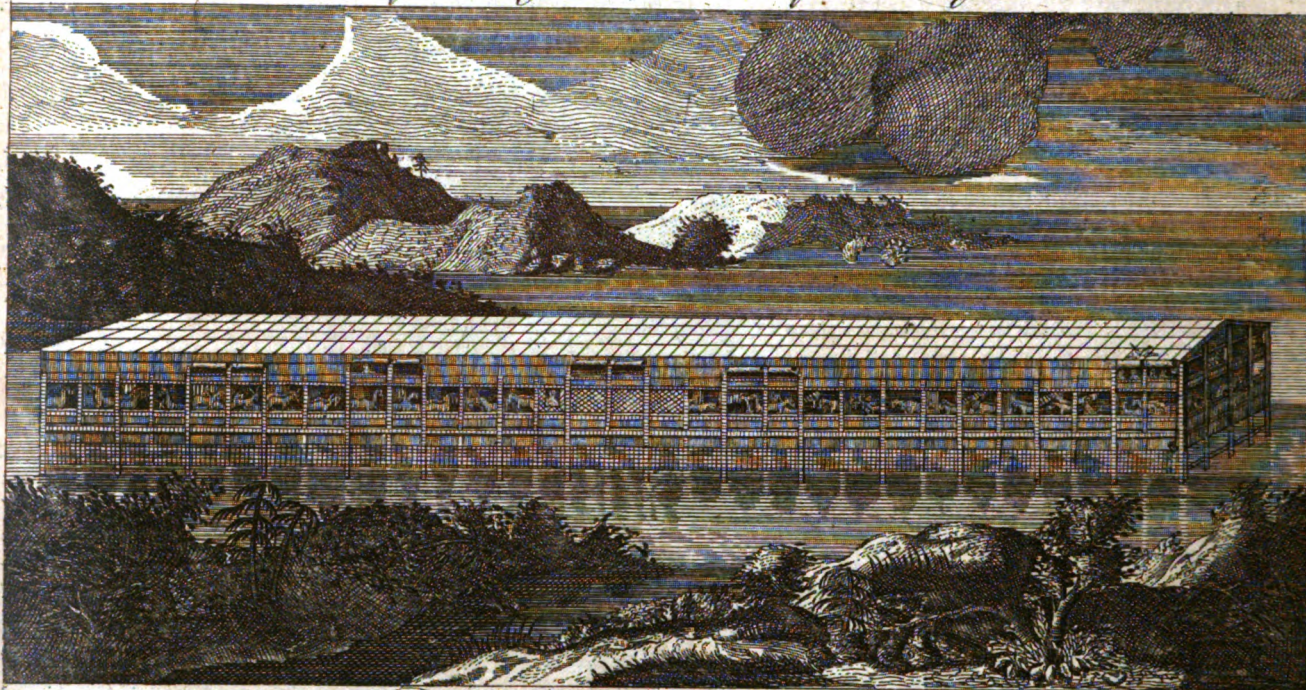
By the description Moses gives of the ark, it appears to have been divided into three stories, each ten cubits, or fifteen feet high; and it is agreed on, as most probable, that the lowest story was for the beasts, the middle for the food, and the upper

for the birds, with Noah and his family; each story being subdivided into different apartments, stalls, &c. Though Josephus, Philo, and other commentators, add a kind of fourth story under all the rest; being, as it were, the hold of the vessel, to contain the ballast, and receive the filth and feces of so many animals: But F. Calmet thinks, that what is here reckoned a story, was no more than what is called the *keel* of ships, and served only for a conservatory of fresh water. Drexelius makes three hundred apartments. F. Fournier, three hundred and thirty-three; the anonymous author of the Questions on Genesis, four hundred; Buteo, Temporius, Arias Montanus, Hostius, Wilkins, Lamy, and others, suppose as many partitions as there were different sorts of animals. Pelletier makes only seventy-two, viz. thirty-six for the birds, and as many for the beasts; his reason is, that if we suppose a greater number, as 333, or 400, each of the eight persons in the ark must have had thirty-seven, forty-one, or fifty stalls to attend and cleanse daily, which he thinks impossible to have been done. But it is observed, that there is not much in this; to diminish the number of stalls without a diminution of animals is vain; it being perhaps more difficult to take care of three hundred animals in seventy-two stalls, than in three hundred. As to the number of animals contained in the ark, Buteo computes that it could not be equal to five hundred horses; he even reduces the whole to the dimensions of fifty-six pair of oxen. F. Lamy enlarges it to sixty-four pair of oxen, or an hundred and twenty-eight oxen; so that supposing one ox equal to two horses, if the ark had room for two hundred and fifty-six horses, there must have been room for all the animals. But the same author demonstrates, that one floor of it would suffice for five hundred horses, allowing nine square feet to a horse.

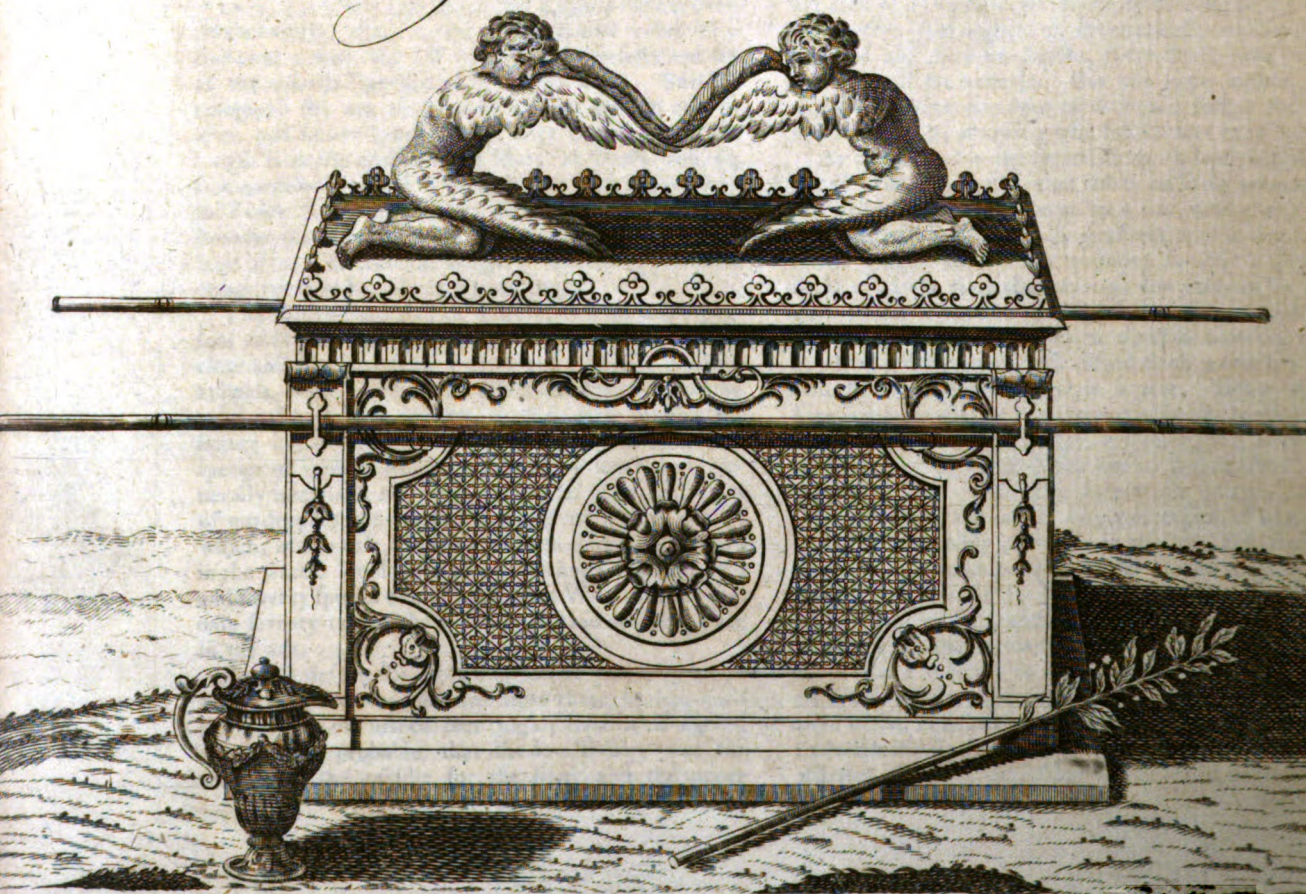
As to the food in the second story, it is observed by Buteo from Columella, that thirty or forty pounds of hay ordinarily suffices for an ox a day, and that a solid cubit of hay, as usually pressed down in our hayricks, weighs about forty pounds; so that a square cubit of hay is more than enough for one ox in one day. Now it appears that the second story contained 150,000 solid cubits, which divided between two hundred and six oxen, will afford each more hay ~~by~~ two thirds, than he can eat in a year. Bishop Wilkins computes all the carnivorous animals, equivalent, as to the bulk of their bodies, and their food, to twenty-seven wolves; and all the rest to two hundred and eighty bees. For the former he allows 1825 sheep, and for the latter, 109,500 cubits of hay, all which will be easily contained in the two first stories, and a deal of room to spare. As to the third story, no body doubts of its being sufficient for the fowls; with Noah, his sons, and daughters. Upon the whole, the learned bishop remarks, that of the two, it appears much more difficult to assign a number and bulk of necessary things to answer the capacity of the ark, than to find sufficient room for the several species of animals already known to have been there. This he attributes to the imperfection of our list of animals, especially



*Fig. 1. NOAH'S ARK  
floating on the waters of the Deluge*



*Fig. 2. ARK of the COVENANT*



specially those of the unknown parts of the earth; adding, that the most expert mathematician at this day could not assign the proportion of a vessel better accommodated to the purpose than is here done; and hence finally concludes, that the capacity of the ark, which had been made an objection against scripture, ought to be esteemed a confirmation of its divine authority, since, in those ruder ages, men, being less versed in arts and philosophy, were more obnoxious to vulgar prejudices than now; so that had it been an human invention, it would have been contrived, according to those wild apprehensions which arise from a confused and general view of things, as much too big, as it had been represented too little.

But it must be observed, that besides the places requisite for the beasts and birds, and their provisions, there was room required for Noah to lock up household utensils, the instruments of husbandry, grains and seeds, to sow the earth with after the deluge; for which purpose it is thought that he might spare room in the third story for six and thirty cabins, besides a kitchen, a hall, four chambers, and a space about eight and forty cubits in length to walk in.

**ARK of the covenant**, a small chest or coffer, three feet nine inches in length, two feet three inches in breadth, and two feet three inches in height, in which were contained the golden pot that had manna, and Aaron's rod, and the tables of the covenant. This coffer was made of shittim-wood, and was covered with the mercy-seat, which was of solid gold; at the two ends whereof were two cherubims, looking toward each other, with expanded wings, which, embracing the whole circumference of the mercy-seat, met on each side in the middle. The whole, according to the rabbins, was made out of the same mass, without joining any of the parts by solder. Here it was that the Schechinah or Divine Presence rested, both in the tabernacle and in the temple, and was visibly seen in the appearance of a cloud over it; and from hence the Divine oracles were given out by an audible voice, as often as God was consulted in the behalf of his people. Plate XXXVIII. fig. 2.

**ARKLOW**, a sea-port town of Ireland, situated in the county of Wicklow, about thirteen miles south of the city of Wicklow, in  $6^{\circ} 20'$  W. long. and  $52^{\circ} 55'$  N. lat.

**ARLES**, a city of Provence in France, situated on the eastern shore of the river Rhone, in  $4^{\circ} 45'$  E. long. and  $43^{\circ} 32'$  N. lat.

**ARLEUX**, a town of Hainault, in the French Netherlands, situated about six miles south of Douay, in  $3^{\circ}$  E. long. and  $50^{\circ} 20'$  N. lat.

**ARLON**, a town of the duchy of Luxemburg, on the Austrian Netherlands, situated in  $5^{\circ} 30'$  E. long. and  $49^{\circ} 45'$  N. lat.

**ARM**, in riding, is applied to a horse, when, by pressing down his head, he endeavours to defend himself against the bit, to prevent obeying, or being checked thereby.

**ARMADA**, a Spanish term, signifying a fleet of men of war, as *arnadilla* signifies a squadron.

**ARMADABAT**, a very large city of Asia, the metropolis of the kingdom of Guzarat.

**ARMADILLO**, in zoology, a synonyme of the *dasypus*. See *DASYPUS*.

**ARMAGH**, once a considerable city of Ireland, but now much reduced, situated about thirty miles south of Londonderry, in  $6^{\circ} 45'$  W. long. and  $54^{\circ} 30'$  N. lat. It is still the see of the primate of Ireland, and gives name to the county of Armagh.

**ARMAGNAC**, a district or territory in the north-east part of Gascony in France.

**ARMAN**, in farriery. See *DRENCH*.

**ARMED**, in the sea-language. A cross-bar shot, is said to be armed, when some rope-yarn or the like is rolled about the end of the iron bar, which runneth through the shot.

**ARMED**, in heraldry, is used when the horns, feet, beak, or talons of any beast or bird of prey, are of a different colour from the rest of their body.

**ARMENIA**, a large country of Asia, comprehending Turcomania and part of Persia.

**ARMENIACA**, in botany. See *PRUNUS*.

**ARMENIANS**, in church-history, a sect among the eastern Christians; thus called from Armenia, the country anciently inhabited by them. There are two kinds of Armenians, the one catholic and subject to the pope, having a patriarch in Persia, and another in Poland; the other makes a peculiar sect, having two patriarchs in Natolia. They are generally accused of being manophysites, only allowing of one nature in Jesus Christ. As to the eucharist, they for the most part agree with the Greeks; they abstain rigorously from eating of blood and meats strangled, and are much addicted to fasting.

**ARMENTIERS**, a fortified town in French Flanders, situated about seven miles west of Lille, in  $2^{\circ} 50'$  E. long. and  $50^{\circ} 42'$  N. lat.

**ARMIERS**, a town of Hainault, in the French Netherlands, situated on the river Sambre, about twenty miles south of Mons, in  $3^{\circ} 40'$  E. long. and  $50^{\circ} 15'$  N. lat.

**ARMIGER**, an esquire, or armour-bearer. See *ESQUIRE*.

**ARMILLARY**, in a general sense, something consisting of rings, or circles.

**ARMILLARY sphere**, an artificial sphere, composed of a number of circles, representing the several circles of the mundane sphere, put together in their natural order, to ease and assist the imagination, in conceiving the constitution of the heavens, and the motions of the celestial bodies. See *GEOGRAPHY*.

**ARMILUSTRIUM**, in Roman antiquity, a feast held among the Romans, in which they sacrificed armed, to the sound of trumpets.

**ARMINGS**, in the sea-language. See *ARMED*.

**ARMINIANS**, in church-history, a sect of Christians which arose in Holland, by a separation from the Calvinists. They are great assertors of free-will. They speak very ambiguously of the presence of God. They look upon the doctrine of the Trinity as a point not necessary to salvation; and many of them hold there is no precept in scripture by which we are enjoined

to adore the Holy Ghost; and that Jesus is not equal to God the Father.

**ARMIRO**, a town of European Turkey, in the province of Theffaly, situated in  $23^{\circ} 30'$  E. long.

**ARMOISIN**, a silk stuff, or kind of taffety, manufactured in the E. Indies, at Lyons in France, and Lucca in Italy. That of the Indies is slighter than those made in Europe.

**ARMONIAIC**, or **AMMONIAC**, a volatile salt, of which there are two kinds, ancient and modern. The ancient sort, described by Pliny and Dioscorides, was a native salt, generated in those large inns or caravanferas, where the croud of pilgrims, coming from the temple of Jupiter Ammon, used to lodge; who, in those parts, traveling upon camels, and those creatures when in Cyrene, a province of Egypt, where that celebrated temple stood, urining in the stables, or, say some, in the parched sands, out of this urine, which is remarkably strong, arose a kind of salt, denominated sometimes, from the temple, *Ammoniac*, and sometimes, from the country, *Cyreniac*. Since the cessation of these pilgrimages, no more of this salt is produced there; and, from this deficiency, some suspect there was never any such thing: But this suspicion is removed, by the large quantities of a salt, nearly of the same nature, thrown out by mount *Ætna*. The characters of the ancient sal armoniac are, that it cools water, turns aqua fortis into aqua regia, and consequently dissolves gold.

The modern sal armoniac is entirely factitious, and made in Egypt; where several long-necked glass bottles, being filled with soot, a little sea-salt, and the urine of cattle, and having their mouth luted with a piece of wet cotton, are placed over an oven or furnace, contrived for the purpose, in a thick bed of ashes, nothing but the necks appearing, and kept there two days and a night, with a continual strong fire. The steam swells up the cotton, and forms a paste at the vent-hole, hindering the salts from evaporating; which, being confined, stick to the top of the bottle, and are, upon breaking it, taken out in those large cakes, which they send to England. Only soot exhaled from dung, is the proper ingredient in this preparation; and the dung of camels affords the strongest and best. See **CHEMISTRY**.

**ARMORIAL**, something relating to arms, or coats of arms. See **ARMS**.

**ARMORY**, a warehouse of arms, or a place where the military habiliments are kept, to be ready for use.

**ARMORY** is also a branch of the science of heraldry, consisting in the knowledge of coats of arms, as to their blazons and various intendments. See **HERALDRY**.

**ARMOUR** denotes such habiliments, as serve to defend the body from wounds, especially of darts, a sword, a lance, &c. A complete suit of armour formerly consisted of a helmet, a shield, a cuirasse, a coat of mail, a gantlet, &c. all now laid aside.

**ARMOURER**, a person who makes or deals in arms and armour.

**ARMS of courtesy**, or *parade*, were lances not shod, swords without edge or point, &c. used in the ancient tournaments. See **TOURNAMENT**.

**Pass of Arms**, a kind of combat, when anciently two or more cavaliers undertook to defend a pass against all attacks.

**ARMS of armories**, in heraldry, marks of honour borne upon shields, banners, and coats, in order to distinguish states, families, and persons. See **HERALDRY**.

**Charged ARMS**, are such as retain their ancient integrity, with the addition of some new honourable bearing.

**Canting**, or *vocal ARMS*, those in which there are some figures alluding to the name of the family.

**Full**, or *entire ARMS*, such as are not conformable to the rules of heraldry.

**ARMS**, in falconry, the legs of a hawk from the thigh to the foot.

**ARMUYDEN**, a sea-port town of the island of Zealand, situated at the mouth of the canal of Middleburg, in  $2^{\circ} 35'$  E. long. and  $51^{\circ} 30'$  N. lat.

**ARMY**, a large number of soldiers, consisting of horse and foot, completely armed, and provided with artillery, ammunition, provisions, &c. under the command of one general, having lieutenant-generals, major-generals, brigadiers, and other officers under him. An army is composed of squadrons and battalions, and is usually divided into three corps, and formed into three lines; the first line is called the van-guard, the second the main body, and the third the rear-guard, or body of reserve. The middle of each line is possessed by the foot; the cavalry form the right and left wing of each line; and sometimes they place squadrons of horse in the intervals between the battalions. When the army is drawn up in order of battle, the horse are placed at five feet distance from each other, and the foot at three. In each line the battalions are distant from each other one hundred and eighty feet, which is nearly equal to the extent of their front; and the same holds of the squadrons, which are about three hundred feet distant, the extent of their own front. These intervals are left for the squadrons and battalions of the second line to range themselves against the intervals of the first, that both may more readily march through these spaces to the enemy: the first line is usually three hundred feet distant from the second, and the second from the third, that there may be sufficient room to rally, when the squadrons and battalions are broken.

This is to be understood of a land army only. A naval, or sea army, is a number of ships of war, equipped and manned with sailors and mariners, under the command of an admiral, with other inferior officers under him. See **NAVY**.

**ARNAY-LE-DUC**, a town of Burgundy in France, situated on the river Arroux, in  $4^{\circ}$  E. long. and  $47^{\circ}$  N. lat.

**ARNHEIM**, a large city of Guelderland, in the United Netherlands, situated on the river Lech; about 10 miles north of Nimeguen, in  $5^{\circ} 50'$  E. long. and  $52^{\circ}$  N. lat.

**ARNICA**, in botany, a genus of the syngenesia polygamia superflua class. The receptacle of the arnica is naked; it has a simple pappus; and the filaments are  
five.

**see**, without antheræ. There are seven species of arnica, all natives of Ethiopia, except the montana and scorpioides, which are found in Germany. The leaves and root of the arnica have been esteemed a specific in resolving coagulated blood; but their operation is so violent, that they are but rarely used.

**ARNO**, a river of Italy, which, after watering Tuscany, falls into the Mediterranean, below Pisa.

**ARNOLDISTS**, in church-history, a sectary, so called from their leader Arnold of Bresse, who was a great declaimer against the wealth and vices of the clergy; and who is also charged with preaching against baptism and the eucharist.

**ARNOT**, in botany, the English name of the bunium. See **BUNIUM**.

**AROLEC**, an American weight, equal to 25 of our pounds.

**AROMA** *philosophorum*, denotes either saffron, or the aroph of Paracelsus, as aroma germanicum denotes elecampane.

**AROMATIC**, an appellation given to such plants as yield a brisk fragrant smell, and a warm taste, as all kinds of spices, &c.

**ARONA**, a fortified town of the Milanese, situated on the south-west part of the lake Maggior, in 8° 50' E. long. and 45° 40' N. lat.

**ARONCHES**, a town of the province of Alentejo, in Portugal, situated in 7° 30' W. long. and 39° N. lat.

**ARO-ORCHIS**, in botany. See **KEMPFERIA**.

**ARORNOS**. See **JUMPERUS**.

**AROURA**, a Grecian measure of fifty feet. It was more frequently used for a square-measure of half the plethorn. The Egyptiaa aroura was the square of one hundred cubits.

**ARQUATA**, in ornithology, the trivial name of a species of scolopax. See **SCOLOPAX**.

**ARRACHEE**, in heraldry, a term applied to the representations of plants torn up by the roots.

**ARRACK**. See **RACK**.

**ARRAIGNMENT**, in law, the arraigning or setting a thing in order, as a person is said to arraign a writ of novel disseisin, who prepares and fits it for trial. It is most properly used to call a person to answer in form of law upon an indictment, &c.

**ARRAN**, an island of Scotland, situated in the Frith of Clyde, between Kintyre and Cunningham.

**ARRAS**, a large fortified town of the French Netherlands, capital of the province of Artois, situated in 2° 50' E. long. and 50° 20' N. lat. It is from this city that the tapestry called *arras hangings* takes its denomination.

**ARRAS**, or *Araxes*, is also the name of a river of Georgia, which discharges itself into the Caspian sea.

**ARREST**, in English law, the apprehending and restraining a person, in order to oblige him to be obedient to the law.

**ARREST of judgment**, the assigning just reasons why judgment should not pass.

**ARRESTMENT**, in Scots law, signifies the securing of a criminal till trial, or till he find caution to stand

trial, in what are called *baillable crimes*. In civil cases, it signifies either the detaining of strangers or natives in *meditatione fugæ*, till they find caution *judicio fisci*, or the attaching the effects of a stranger in order to found jurisdiction. See **SCOTS LAW**, tit. *Jurisdiction and Judges in general*. But, in the most general acceptation of the word, it denotes that diligence by which a creditor detains the goods or effects of his debtor in the hands of third parties till the debt due to him be either paid or secured. See **SCOTS LAW**, tit. *Arrestments and Poidings*.

**ARRESTO fatto super bonis**, &c. a writ brought by a denizen against the goods of aliens found within this kingdom, as a recompence for goods taken from him in a foreign country.

**ARRESTIS**, in farriery, many tumours upon a horse's hinder legs, between the ham and the pattern.

**ARRIERE**, the hinder or posterior part of any thing. See **REAR**.

**ARRIERE-ban**, in the French customs, is a general proclamation, whereby the king summons to the war all that hold of him, both his vassals, *i. e.* the noblesse, and the vassals of his vassals.

**ARRIERE fee**, or *fief*, is a fee dependant on a superior one. These fees commenced, when the dukes and counts, rendering their governments hereditary in their families, distributed to their officers parts of the royal domains, which they found in their respective provinces; and even permitted those officers to gratify the soldiers under them in the same manner.

**ARROE**, an island of Denmark, situated in the Baltic sea, in 10° 15' E. long. and 55° 15' N. lat.

**ARRONDEE**, in heraldry, a cross, the arms of which are composed of sections of a circle, not opposite to each other, so as to make the arms bulge out thicker in one part than another; but the sections of each arm lying the same way, so that the arm is every where of an equal thickness, and all of them terminating at the edge of the escutcheon like the plain cross.

**ARSCHIN**, in commerce, a long measure used in China to measure stuffs. Four arschins make three yards of London.

**ARSHOT**, a town of the Austrian Netherlands, situated about fourteen miles east of the city of Mechlin, in 4° 45' E. long. and 51° 5' N. lat.

**ARSENIC**, a poisonous mineral preparation, which is either white, red, or yellow, prepared from the flosses of cobalt. See **COBALT**, and **CHEMISTRY**.

**ARSENICAL Magnet**, a preparation of white arsenic with antimony and sulphur, said to be a gentle caustic.

**ARSENOTHELYS**; the same with hermaphrodite.

**ARSIN** and *Thefis*, in music. A point is said to move arsin and thesin, which rises in one part and falls in another, and *vice versa*.

**ARSMART**, in botany. See **PERSICARIA**.

**ART**, a system of rules serving to facilitate the performance of certain actions.

**ART** is also an appellation given to several superstitious practices, as, *St Anselm's art*, *St Paul's art*, &c.

**ART and part**, in Scots law. See **ACCESSARY**.

**ARTEDIA**.

- ARTEDIA**, in botany, a genus of the pentandria digynia class. The involucre is pinnatifid; the floccules of the disk are masculine, and the fruit is rough. There is only one species, *viz.* the *squamata*, a native of Libanium.
- ARTEMISIA**, southernwood, in botany, a genus of the syngenesia polygamia superflua class. The receptacle is either naked or a little downy; it has no pappus; the calix is imbricated with roundish scales; and the corolla has no radii. There are 23 species of artemisia, only 4 of which are natives of Britain, *viz.* the *campestris*, or field-southernwood; the *maritima*, or sea-wormwood; the *absinthium*, or common wormwood; and the *vulgaris*, or mugwort. The *vulgaris*, or mugwort, is used both as a pot-herb and as a medicine; the leaves are principally celebrated as uterine and antihysterical. The leaves of the *absinthium* are chiefly used as a bitter or stomachic.
- ARTERIOTOMY**, the opening an artery, with design to procure an evacuation of blood.
- ARTERY**, in anatomy, a conical tube or canal which conveys the blood from the heart to all parts of the body. See **ANATOMY**, Part III.
- ARTHRITIS**, in medicine, the gout. See **GOUT**, and **MEDICINE**.
- ARTHRODIA**, in natural history, a genus of imperfect crystals, found always in complex masses, and forming long single pyramids, with very short and slender columns. See **CRYSTAL**.
- ARTHRODIA**, in anatomy, a species of articulation, wherein a flat head of one bone is received into a shallow socket of another.
- ARTICHOAK**, in botany. See **CINARA**.
- ARTICLE**, a clause or condition of a contract, treaty, &c. It is also a small part or division of a discourse, a book, or writing, &c.
- ARTICLE**, in grammar, a particle in most languages that serves to express the several cases and genders of nouns, when the language has not different terminations to denote the different states and circumstances of nouns. See **GRAMMAR**.
- ARTICULARIS morbus**. See **GOUT**, and **MEDICINE**.
- ARTICULATE sounds** are such sounds as express the letters, syllables, or words of any alphabet or language: such are formed by the human voice, and by some few birds, as parrots, &c.
- ARTICULATION**, in anatomy, denotes the juncture of two bones intended for motion.
- ARTIFICER**, a person whose employment it is to manufacture any kind of commodity, as in iron, brass, wood, &c. such are smiths, weavers, carpenters, &c.
- ARTIFICIAL**, in a general sense, denotes something made, fashioned, or produced by art, in contradistinction from the productions of nature.
- ARTILLERY**, large fire-arms, with their appurtenances, as cannons, mortars, bombs, petards, muskets, carabines, &c. See **CANNON**, **MORTAR**, **GUNNERY**.
- ARTILLERY-park**, the place in the rear of both lines in the army, for encamping the artillery, which is drawn up in lines, of which one is formed by the guns; the ammunition-waggons make two or three lines, sixty paces behind the guns, and thirty distant from one another; the pontoons and tumbrils make the last line. The whole is surrounded with a rope which forms the park; the gunners and matrosses encamp on the flanks, and the bombardiers, poon-men, and artificers, in the rear.
- ARTILLERY-train**, a certain number of pieces of ordnance, mounted on carriages, with all their furniture fit for marching.
- ARTILLERY-company**, a band of infantry, consisting of six hundred men, making part of the militia or city-guard of London.
- ARTISCUS**, in medicine. See **TROCHE**.
- ARTOIS**, a province of the French Netherlands, situated between Flanders and Picardy.
- ARVALES fratres**, in Roman antiquity, a college of twelve priests, instituted by Romulus, who himself made one of the body: they assisted in the sacrifices of the ambervalia, offered annually to Ceres and Bacchus, for the prosperity of the principal fruits of the earth, *viz.* those of corn and wine.
- ARUBA**, a small island on the coast of Terra Firma, subject to the Dutch, and situated in 69° 30' W. long. and 12° 30' N. lat.
- ARUM**, in botany, a genus of the gynandria polyandria class. There are 22 species of arum, only one of which, *viz.* the *maculatum*, or water-robin, is a native of Britain. The root of the *maculatum* is a powerful stimulant and attenuant.
- ARUNCUS**, in botany, the trivial name of a species of *spizæa*. See **SPIZÆA**.
- ARUNDEL**, a town of Sussex, situated on a river of the same name, in 30' W. long. and 50° 45' N. lat. It gives the title of earl to the noble family of the Howards, and sends two members to parliament.
- ARUNDO**, in botany, a genus of the triandria digynia class. The calix consists of two valves, and the floccules are thick and downy. There are six species of arundo, four of which are natives of Britain, *viz.* the *phragmitis*, or common red-grass; the *calamogrestis*, or branched red grass; the *epigejos*, or small red-grass; and the *arenaria*, or sea red-grass.
- ARUSPICES**, or **HARUSPICES**, an order of priesthood among the Romans, that pretended to foretel future events by inspecting the entrails of victims killed in sacrifice; they were also consulted on occasion of portents and prodigies.
- ARYTÆNOIDES**, in anatomy, the name of two cartilages which, together with others, constitute the head of the larynx. It is also applied to some muscles of the larynx. See p. 300.
- ARYTÆNOIDEUS**, in anatomy, one of the muscles that close the larynx. See p. 301.
- ARYTHMUS**, in medicine, the want of a just modulation in the pulse. It is opposed to eurythmus, a pulse modulated agreeably to nature.
- ARZILLA**, a sea-port town of the empire of Morocco, situated about 15 miles south of Tangier, in 5° 40' W. long. and 35° 40' N. lat.



**AS**, in antiquity, a particular weight, consisting of twelve ounces, being the same with libra, or the Roman pound. It was also the name of a Roman coin, which was of different matter and weight, according to the different ages of the commonwealth. It is also used to signify an integer, divisible into twelve parts; from which last acceptance it signified a whole inheritance.

**ASAFOETIDA**, in the materia medica, the concrete juice of a large umbelliferous plant growing in Persia.

This juice exudes from wounds made in the root of the plant, liquid and white like milk. When exposed to the air, it turns of a brownish colour, and gradually acquires different degrees of consistence. It is brought to us in large irregular masses, composed of various little shining grains, which are partly whitish, partly reddish, and partly of a violet colour. Those masses are accounted the best which are clear, of a pale reddish colour, and variegated with a great number of elegant white tears. This drug has a strong foetid smell like garlic, and a bitter, acrid, biting taste. It is frequently used in hysteric and nervous complaints, flatulent colics, and as a promoter of the menses. It is likewise an ingredient in the official gum-pills, and several other compositions.

**ASA dulcis**. See **BENZOIN**.

**ASAPH**, or *St ASAPH*, a city of Flintshire in North Wales, situated about 20 miles N. W. of Chester, in 30° 30' W. long. and 53° 18' N. lat.

**ASAPPE**, or *AZAPPE*, in the Turkish armies, a name given to the auxiliary troops which they raise among the Christians under their dominion, and expose to the first shock of the enemy.

**ASARABACCA**, in botany. See **ASARUM**.

**ASARINA**, in botany, a synonyme of the chelone. See **CHELONE**.

**ASARUM**, in botany, a genus of the dodecandria monogynia class. The asarum is quinquid, and rests on the germen; it has no corolla. The species are four, only one of which, *viz.* the europæum, is a native of Britain. It is a strong sternutatory, and occasions great evacuations, both upwards and downwards.

**ASBESTOS**, a sort of native fossile stone, which may be split into threads and filaments, from one inch to ten inches in length, very fine, brittle, yet somewhat tractable, silky, and of a greyish colour, not unlike talc of Venice. It is almost insipid to the taste, indissoluble in water, and endued with the wonderful property of remaining unconsumed in the fire, which only whitens it. But, notwithstanding the common opinion, in two trials before the Royal Society, a piece of cloth made of this stone was found to lose a dram of its weight each time. Paper as well as cloth has been made of it; and Pliny says he had seen napkins of it, which, being taken foul from the table, were thrown into the fire, and better scoured than if they had been washed in water. This stone is found in many places of Asia and Europe; particularly in the island of Anglesey in Wales, and in Aberdeenshire in Scotland.

**ASCARIS**, in zoology, a genus of insects belonging to

the order of vermes intestina. The body of the ascaris is cylindrical, filiform, and tapers at both ends.

The species are two, *viz.* 1. The vermicularis is about a quarter of an inch long, and is found in lakes, in the roots of putrid plants, and very frequently in the rectum of children and horses. 2. The lumbricoides is about the same length with the lumbricus terrestris, or common earth-worm, but it wants the protuberant ring towards the middle of the body, the only mark by which they can properly be distinguished. The body of the lumbricoides is cylindrical, and subulated at each extremity; but the tail is somewhat triangular. The lumbricoides is the worm which is most commonly found in the human intestines. For the method of expelling these two kinds of insects, see **MEDICINE**, *Of worms*.

**ASCENDANTS**, in law, are opposed to descendents in succession; *i. e.* when a father succeeds his son, or an uncle his nephew, &c. heritage is said to ascend, or go to ascendants.

**ASCENDENS obliquus**, the same with the obliquus internus abdominis. See **ANATOMY**, p. 192.

**ASCENDING**, in astronomy, is said of such stars as are rising above the horizon in any parallel of the equator.

**ASCENDING vessels**, in anatomy, those which carry the blood upwards, as the aorta ascendens.

**ASCENSION**, in astronomy, is either right or oblique. Right ascension of the sun, or a star, is that degree of the equinoctial, counted from the beginning of aries, which rises with the sun or star in a right sphere. Oblique ascension is an arch of the equator intercepted between the first point of aries, and that point of the equator which rises together with a star in an oblique sphere.

**ASCENSION-day**, a festival of the Christian church, held ten days before Whitsuntide, in memory of our Saviour's ascension into heaven after his resurrection.

**ASCENSION-island**, an uninhabited island, lying almost in the midway between Africa and Brazil, in 17° W. long. and 7° S. lat.

**ASCENSIONAL difference**, the difference between the right and oblique ascension of the same point to the surface of the sphere. See **ASTRONOMY**.

**ASCENT of bodies on inclined planes**. See **MECHANICS**.

**ASCENT of fluids**. See **HYDROSTATICS**.

**ASCETICS**, in church-history, such Christians in the primitive church as enured themselves to great degrees of abstinence and fasting, in order to subdue their passions.

**ASCHAFFENBURG**, a city of Germany, situated on the river Mayne, in the ... of the Lower Rhine; about 20 miles east of Frankfurt, in 9° E. long. and 50° 15' N. lat.

**ASCIDIA**, a genus of insects belonging to the order of vermes mollusca. The body is cylindrical and sheathy; it has two apertures towards the top, the one a little lower than the other. There are six species of this insect, *viz.* the papillosum, gelatinosum, intestinalis, 5 Q quadridentata;

- quadridentata, rustica, and echinata, all inhabitants of the ocean.
- ASCI**, among geographers, an appellation given to those inhabitants of the earth who, at certain seasons of the year, have no shadow: such are all the inhabitants of the torrid zone, when the sun is vertical to them.
- ASCITES**, in medicine, the dropsy. See **DROPSY**, and **MEDICINE**.
- ASCLEPIAD**, in ancient poetry, a verse composed of four feet, the first of which is a spondee, the second a choriambus, and the two last dactyls; or of four feet and a cæsura, the first a spondee, the second a dactyl, after which comes the cæsura, then the two dactyls, as,  
*Macenas atavis edite regibus.*
- ASCLEPIAS**, in botany, a genus of the pentandria digynia class. The generic character is taken from five oval, concave, horn-like nectaria, which are found in the flower. There are 18 species of asclepias, none of which grow wild in Britain. The root is used by the French and German physicians as a sudorific, diuretic, and emmenagogue; but it is not in use with us.
- ASCODRUTÆ**, in church-history, a sort of Gnostics, who placed all religion in knowledge; and, under pretence of spiritual worship, would admit of no external or corporeal symbols whatever.
- ASCOLI**, a city in the marquisate of Ancona in Italy, situated on the river Tronto, in 15° E. long. and 42° 50' N. lat. It is also a city of the kingdom of Naples, situated in the province of Capitanata, in 16° 30' E. long. and 41° 15' N. lat.
- ASCOLIA**, in Grecian antiquity, a festival celebrated by the Athenian husbandmen in honour of Bacchus, to whom they sacrificed a he-goat, because that animal destroys the vines.
- ASCUS**, in natural history, the pouch or bag of the opossum. See **OPOSSUM**.
- ASCYRUM**, in botany, a genus of the polyadelphia polyandria class. The calix consists of four leaves; the corolla has four petals; the filaments are numerous, and divided into four bundles. The species are three, viz. the crux andrea, the hypericoides, and the villosum, all natives of the West-Indies or America.
- ASELLUS**, in zoology, the trivial name of a species of oniscus. See **ONISCUS**.
- ASH**, in botany. See **FRAXINUS**.
- ASHBURTON**, a town of Devonshire, situated about twenty-two miles S. W. of Exeter, in 4° 15' W. long. and 50° 30' N. lat.
- ASHBY DE LA ZOUCH**, a market-town of Leicestershire, in 1° 25' W. long. and 52° 40' N. lat.
- ASHES**, the earthy part of wood and other combustibles, remaining after they are consumed by fire. These, if produced from a vegetable, are of a white colour and saltish taste, and, when boiled with fair water, yield a lixivium of an acrimonious, alkaline, fiery, urinous taste. The ashes of all vegetables are vitrifiable, and are found to contain iron. See **AGRICULTURE**, and **CHEMISTRY**.
- ASHFORD**, a market-town of Kent, situated about 12 miles S. W. of Canterbury, in 45° E. long. and 51° 15' N. lat.
- ASIA**, one of the four great parts of the world, and the second in order. It is bounded on the N. by the Frozen Sea, on the E. by the Eastern Ocean, which is part of the South Sea, on the S. by the Indian Sea, and on the W. by Europe and Africa. It is of larger extent than any of the three parts in our continent. Arts and sciences were early cultivated here; though they are thought to have come originally from Egypt: but all the considerable religions now known had their first beginning in Asia; and there are still a great number of people who maintain their ancient tenets, which, according to them, are a hundred thousand years old. They have one sort of religion in China, and another in India, whose priests are the Brachmins; and not to mention the Jews, Christians, and Mahometans, whose beginnings are sufficiently known to all the world. This was the seat of several ancient empires or monarchies; such as that of the Assyrians, Medes, Persians, and Greeks. It is 4740 miles in length from the Dardanel on the W. to the eastern shore of Tartary; and 4380 in breadth from the most southern part of Malacca, to the most northern cape of Nova Zembla. It may be divided into ten great parts, namely, Turkey in Asia, Arabia, Persia, the Mogul's empire, with the two peninsulas of India, Thibet, China, and Corea; Great and Little Bocharia, with Carazm, Little and Great Tartary, Siberia, and the Islands. The governments of Asia are generally monarchical; and Turkey, Persia, the Mogul's Empire, Thibet, and China, are subject to single monarchs; but the rest is divided among several sovereigns; inasmuch that there are reckoned seven emperors, and 30 kings, besides petty princes, and the rajahs of India, which are very numerous. With regard to the extent of their religions, the Christian is but small in respect of the Mahometan, which comprehends one third of Asia; and the Pagan is near twice as much extended as the Mahometan. Beside these, some pretend there is the natural religion, which has about as many followers as the Christian. The languages are so many and so various, that it is impossible to enumerate them; but the chief are the Turkish, the Grecian, the Arabic, the Chinese, the Persian, and the Old Indian. In short, every country and island has almost a distinct language. Besides the animals we have in Europe, there are lions, leopards, tigers, camels, elephants, rhinoceroses, and many others.
- Lesser Asia*, the same with Natolia. See **NAVOLIA**.
- ASILUS**, or hornet-fly, a genus of insects belonging to the order of insecta diptera. It has two wings, a horny, strait, two-valved beak. There are 17 species of this insect.
- ASINUS**, or Ass, in zoology, the name of a species of equus. See **EQUUS**.
- ASIO**, in ornithology, a synonyme of a species of strix. See **STRIX**.
- ASISIO**, or ASITIO, a city of the pope's territories in Italy, situated about 16 miles E. of Perugia, in 13° 35' E. long. and 43° N. lat.

ASLANI.

**ASLANI**, in commerce, a silver coin, worth from 115 to 120 aspers. See **ASPER**.

**ASMER**, a province of India, on this side the Ganges.

**ASPIS**, in zoology, the trivial name of a species of coluber. See **COLUBER**.

**ASPALATHUS**, or **ROSE-WOOD**, in botany, a genus of the diadelphia decandria class. The calix consists of five divisions; the pod is oval, and contains two seeds. There are 19 species, none of them natives of Britain.

**ASPARAGUS**, in botany, a genus of the hexandria monogynia class. The corolla consists of six erect divisions; the three inferior petals are bent outwards; the berry has three cells, and contains two seeds. There are 14 species of asparagus, only one of which, *viz.* the officinalis, is a native of Britain. This species is commonly used as food; but it is also supposed to promote urine.

**ASPECT**, in astronomy, denotes the situation of the planets and stars with respect to each other. See **ASTRONOMY**.

**ASPEN-TREE**, in botany. See **POPULUS**.

**ASPER**, in grammar, an accent peculiar to the Greek language, marked thus (´), and importing, that the letters over which it is placed ought to be strongly aspirated, or pronounced as if an *h* were joined with them.

**ASPER**, in ichthyology, the trivial name of a species of perca. See **PERCA**.

**ASPER**, or **ASPRE**, in commerce, a Turkish coin, three of which make a medine, and worth something more than our halfpenny.

**ASPERSA arteria**, in anatomy, the same with the wind-pipe or trachea. See **ANATOMY**, p. 281.

**ASPERIFOLIATE**, or **ASPERIFOLIOUS**, among botanists, such plants as are rough-leaved, having their leaves placed alternately on their stalks, and a monopetalous flower divided into five parts.

**ASPERUGO**, in botany, a genus of the pentandria monogynia class. There are two species, *viz.* the procumbens, or wild buglos, a native of Britain; and the *egyptiaca*, a native of Egypt.

**ASPERULA**, in botany, a genus of the tetrandria monogynia class. The corolla is infundibuliform, and the capsule contains two globular seeds. There are six species, of which the odorata, or wood-roof, and the cynanchica, or squinancy-wort, are natives of Britain.

**ASPHALTUM**, in natural history, a solid, dark, opaque, inflammable substance, found in Egypt about the Dead Sea, and in many places of Europe, in detached masses of no regular structure, breaking easily in any direction, very light, fusible, and, after burning some time with a greenish white flame, leaving a white residuum of ashes. Dr. Hill enumerates three species of it, the first being the bitumen judaicum, which is of a discutient quality, promotes the menstrual discharge, and enters as an ingredient into the Venice treacle. See **BITUMEN**.

**ASPHODELUS**, in botany, a genus of the hexandria

monogynia class. The calix is divided into six parts; and the nectarium consists of six valves covering the germen. There are three species, *viz.* the buteus, a native of Sicily; the fistulosus and ramosus, both natives of Spain. *&c.*

**ASPHURELATA**, in natural history, are semi-metallic fossils, fusible by fire, and not malleable in their purest state, being in their native state intimately mixed with sulphur and other adventitious matter, and reduced to what are called ores.

Of this series of fossils, there are only five bodies, each of which makes a distinct genus; and these bodies are antimony, bismuth, cobalt, zinc, or quicksilver. See **CHEMISTRY**.

**ASPIRATE**, in grammar, denotes words marked with the spiritus asper. See **ASPER**.

**ASPIRATION**, among grammarians, is used to denote the pronouncing a syllable with some vehemence.

**ASPLENIUM**, in botany, a genus of the cryptogamia filices class. The parts of fructification are situated in the small sparse line under the disk of the leaves.

There are 24 species, five of which, *viz.* the scolopendrium or hart's tongue, the ceterach or spleenwort, the trichomanes or common maiden-hair, the viride or green maiden-hair, are natives of Britain. The ceterach is recommended for promoting urine, and as a pectoral.

**ASPREDO**, in ichthyology, the trivial name of a species of silurus. See **SILURUS**.

**ASS**, in zoology, is ranked as a species of equus, or horse. See **EQUUS**.

**ASSAI**, in music, signifies quick; and, according to others, that the motion of the piece be kept in a middle degree of quickness or slowness. *As, assai allegro, assai presto.* See **ALLEGRO**, and **PRESTO**.

**ASSARON**, or **OMER**, a measure of capacity, in use among the Hebrews, containing five pints. It was the measure of manna which God appointed for every Israelite.

**ASSASSIN**, a person who kills another by attacking him at some disadvantage. It is also meant of one who hires himself to murder a person, in order to revenge the quarrel of another.

**ASSAULT**, in law, a violent injury offered to a man's person, being of a higher nature than battery.

**ASSAULT**; in the military art, a furious effort made to carry a fortified post, camp, or fortress, wherein the assailants do not screen themselves by any works: while the assault continues, the batteries cease, for fear of killing their own men.

**ASSAY**, **ESSAY**, or **SAY**, in metallurgy, the trial of the goodness and purity of metals. Hence,

**ASSAYING** is the art of finding how much pure metal is contained in any ore, or the proportion of the several ingredients of any mixed metal. See **CHEMISTRY**.

**ASSAYING** of weights and measures, the examining the common weights and measures by the clerk of the market.

**ASSAYING**, in music, a flourishing before one begins to play;

- play; or the running divisions, to lead one into the piece before us.
- ASSAY-MASTER**, an officer appointed by certain corporations to make a just assay of all gold and silver brought to him, and to make a true report thereof.
- ASSEMBLAGE**, the uniting or joining of things together; or the things themselves so united or joined. It is also used, in a more general sense, for a collection of various things so disposed and diversified that the whole produces some agreeable effect.
- ASSESSOR**, an inferior officer of justice, appointed chiefly to assist the ordinary judge with his opinion and advice.
- Assessor** is also one who assesses, or settles taxes and other public dues.
- ASSEVERATION**, a positive and vehement affirmation of something.
- ASSIDEANS**, in Jewish antiquity. See **HASSIDEANS**.
- ASSIENTO**, a Spanish word signifying a farm, in commerce, is used for a bargain between the king of Spain and other powers, for importing negroes into the Spanish dominions in America, and particularly to Buenos Ayres. The first assiento was made by the French Guinea company; and, by the treaty of Utrecht, transferred to the English, who were to furnish four thousand eight hundred negroes annually.
- ASSIGN**, in common law, a person to whom a thing is assigned or made over.
- ASSIGNEE**, in law, a person appointed by another to do an act, transact some business, or enjoy a particular commodity.
- ASSIGNING**, in a general sense, is the giving over a right to another; and in a special sense is used to set forth and point at, as to assign an error, to assign false judgment, to assign waste; in which cases it must be shewn wherein the error is committed, where and how the judgment is unjust; and where the waste is committed.
- ASSIGNMENT**, the transferring the interest one has in a lease, or other thing, to another person.
- ASSIMILATION**, in physics, is that motion by which bodies convert other bodies related to them, or at least such as are prepared to be converted, into their own substance and nature. Thus, flame multiplies itself upon oily bodies, and generates new flame; air upon water, and produces new air; and all the parts, as well similar as organical, in vegetables and animals, first attract with some election or choice, nearly the same common or not very different juices for aliment, and afterwards assimilate or convert them to their own nature.
- ASSIS**, in natural history, a term used to denote opium, or the powder of hempseed, which being formed into bolusses is swallowed by the Egyptians, who are thereby intoxicated.
- ASSISER**, or **ASSIZER**, of weights and measures, an officer who has the oversight of those things. See *Clerk of the market*.
- ASSIZE**, in law. See **JURY**.
- ASSOCIATION** of ideas, is where two or more ideas constantly and immediately follow one another, so that the one shall almost infallibly produce the other. See **METAPHYSICS**.
- ASSOILZIE**, in law, to absolve, or free.
- ASSONANCE**, in rhetoric or poetry, is where the words of a phrase or verse have nearly the same sound or termination, but make no proper rhyme.
- ASSOS**, a sea-port town of Natolia, situated about twelve miles south-east of Troas, in 27° 30' E. long. and 38° 30' N. lat.
- ASSUMPSIT**, a voluntary or verbal promise, whereby a person assumes, or takes upon him to perform or pay any thing to another.
- ASSUMPTION**, a festival in the Romish church, in honour of the miraculous ascent of the Virgin Mary into heaven: the Greek church, who also observe this festival, celebrate it on the fifteenth of August with great ceremony.
- ASSUMPTION**, in logic, is the minor or second proposition in a categorical syllogism.
- ASSUMPTION** is also used for a consequence drawn from the propositions whereof an argument is composed.
- ASSUMPTION**, in geography, a city of S. America, situated near the mouth of the river Plata, and on the opposite shore to Buenos Ayres, in 60° W. long. and 34° S. lat.
- ASSUMPTIVE arms**, in heraldry, are such as a person has a right to assume, with the approbation of his sovereign, and of the heralds: Thus, if a person, who has no right by blood, and has no coat of arms, shall captivate, in any lawful war, any gentleman, nobleman, or prince, he is, in that case, intitled to bear the shield of that prisoner, and enjoy it to him and his heirs for ever.
- ASSURANCE**, or **INSURANCE**, in commerce. See **INSURANCE**.
- ASSUROR**, a merchant, or other person, who makes out a policy of assurance, and thereby insures a ship, house, or the like.
- ASSYRIA**, an ancient empire of Asia, comprehending the modern provinces of Curdistan, Diarbec, and Irac-arabic.
- ASSYTH**, or **ASSYTHMENT**, in Scots law, signifies an indemnification made to an injured party. See **SCOTS LAW**, tit. *Crimes*.
- ASTER**, in botany, a genus of the syngenesia polygamia superflua class. The receptacle is naked; the pappus is simple; the rays of the corolla are ten; and the calix is imbricated. The species are thirty-six, only one of which, viz. the tripolium, or sea-starwort, is a native of Britain.
- ASTERABAT**, a city of Persia, capital of a province of the same name, situated on the southern shore of the Caspian sea, in 54° E. long. and 37° 30' N. lat.
- ASTERIA**, in natural history, a beautiful pellucid gem of variable colours, as viewed in different lights; called also *oculus cati*, or *cat's eye*. The variable colours, which are a pale brown and white, seem to be lodged deep in the stone, and shift about as it is moved. It is nearly allied to the opals; from which, however,

- however, it is distinguished by its colour and superior hardness.
- ASTERIA** is also the name of an extraneous fossil, called in English the *star-stone*. See **STAR-STONE**.
- ASTERIAS**, or **STAR-FISH**, in zoology, a genus of insects of the order of vermes molusca. The body is depressed, with a hard crust, and prickly tentacula: The mouth is in the centre, and has five valves. There are sixteen species of asterias, all found in different seas.
- ASTERISCUS**, in botany, a synonyme of the anthemis. See **ANTHEMIS**.
- ASTERISK**, a mark in form of a star, \*, placed over a word or sentence, to refer the reader to the margin, or elsewhere, for a quotation, explanation, or the like.
- ASTEROCEPHALUS**, in botany. See **SCABIOSA**.
- ASTEROIDES**, in botany. See **BUPHTHALMUM**.
- ASTEROPODIUM**, a kind of extraneous fossil, of the same substance with the asterizæ, or star-stones, to which they serve as a base. See **STAR-STONE**.
- ASTROPTERUS**, in botany, a synonyme of the aster. See **ASTER**.
- ASTHMA**, in medicine, a painful, difficult, and laborious respiration. See **MEDICINE**.
- ASTI**, a city of Piedmont, in Italy, situated upon the river Panaro, about thirty miles east of Turin, in 8° 15' E. long. and 44° 40' N. lat.
- ASTORGA**, a city of the province of Leon, in Spain, situated upon the river Inerto, about thirty miles south-west of Leon, in 6° 20' W. long. and 42° 20' N. lat.
- ASTOUR**, in commerce, a term in the E. Indies, for what in England we call discount. See **DISCOUNT**.
- ASTRACAN**, a city of Asiatic Russia, and capital of a kingdom of the same name. It is situated on the eastern shore of the river Wolga, about eighty miles north of the Caspian sea, in 52° E. long. and 47° N. lat.
- ASTRAGAL**, in architecture, a little round moulding, in form of a ring, serving as an ornament at the tops and bottoms of columns. See **ARCHITECTURE**.
- ASTRAGAL**, in gunnery, a round moulding encompassing a cannon, about half a foot from its mouth.
- ASTRAGALOIDES**, in botany, a synonyme of the phaca. See **PHACA**.
- ASTRAGALUS**, in botany, a genus of the diadelphia decandria class. The <sup>120 ju</sup>pod is gibbous and bilocular. There are thirty-nine species of astragalus, of which two, viz. the glycyphyllus, or wild liquorice, and the arenarius, or purple mountain milk-work, are natives of Britain.
- ASTRAGALUS**, in anatomy. See p. 185.
- ASTRANTIA**, in botany, a genus of the pentandria
- digynia class. The involucre is lanceolated, open, equal, and coloured. The species are two, viz. the major and minor, both natives of the Alps.
- ASTRARIUS hares**, in law, is where an ancestor by conveyance has settled his heir apparent and family in a house in his life-time.
- ASTREA**, in astronomy, the same with virgo. See **VIRGO**, and **ASTRONOMY**.
- ASTRENIUM**, in botany, a genus of the diœcia pentandria class. There is but one species, a native of America.
- ASTRICTION**, in law. See **THIRLAGE**.
- ASTRICTION**, among physicians, denotes the operation of astringent medicines. See the next article.
- ASTRINGENTS**, in materia medica, substances distinguished by a rough austere taste, and changing solutions of iron, especially those made in the vitriolic acid, into a dark purple or black colour; such are galls, tormentil root, bistort root, balauftines, terra japonica, acacia, &c. Astringents yield their virtues by infusion both to water and vinous spirits, but generally in greatest perfection to the former. The medical effects of astringents are, to constrict the fibres, and incrassate or lightly thicken the juices. Their more experienced use is in disorders proceeding from a debility or flaccid state of the solids; in hæmorrhages from a thinness of the blood, laxity, or rupture of the vessels; in preternatural discharges of other kinds, after the offending matter has been duly corrected or evacuated; and in external relaxations.
- ASTROGNOSIA**, the science of the fixed stars, or the knowledge of their names, constellations, magnitudes, &c.
- ASTROITES**, or **STAR-STONE**, in natural-history, is so called on account of its resemblance to a star. See **STAR-STONE**.
- ASTROLABE**, the name for a stereographic projection of the sphere, either upon the plane of the equator, the eye being supposed to be in the pole of the world; or upon the plane of the meridian, when the eye is supposed in the point of the intersection of the equinoxial and horizon.
- ASTROLABE** is also an instrument for taking the altitude of the sun or stars at sea. See **ASTRONOMY**.
- ASTROLABE**, among the ancients, was the same as our armillary sphere.
- ASTROLOGY**, a conjectural science, which teaches to judge of the effects and influences of the stars, and to foretel future events by the situation and different aspects of the heavenly bodies. This science has long ago become a just subject of contempt and ridicule.
- ASTRONOMICALS**, a name sometimes given to sexagesimal fractions. See **ARITHMETIC**, *Of sexagesimals*.

# A S T R O N O M Y.

**A**STRONOMY is the science which treats of the nature and properties of the heavenly bodies.

## CHAP. I. *Of ASTRONOMY in general.*

By astronomy we discover that the earth is at so great a distance from the sun, that if seen from thence it would appear no bigger than a point, although its circumference is known to be 25,020 miles. Yet that distance is so small, compared with the earth's distance from the fixed stars, that if the orbit in which the earth moves round the sun were solid, and seen from the nearest star, it would likewise appear no bigger than a point, although it is at least 162 millions of miles in diameter. For the earth, in going round the sun, is 162 millions of miles nearer to some of the stars at one time of the year than at another; and yet their apparent magnitudes, situations, and distances from one another still remain the same; and a telescope which magnifies above 200 times does not sensibly magnify them; which proves them to be at least 400 thousands times farther from us than we are from the sun.

It is not to be imagined that all the stars are placed in one concave surface, so as to be equally distant from us; but that they are scattered at immense distances from one another through unlimited space. So that there may be as great a distance between any two neighbouring stars, as between our sun and those which are nearest to him. Therefore an observer, who is nearest any fixed star, will look upon it alone as a real sun; and consider the rest as so many shining points, placed at equal distances from him in the firmament.

By the help of telescopes we discover thousands of stars which are invisible to the naked eye; and the better our glasses are, still the more become visible; so that no limits can be set either to their number or their distances.

The sun appears very bright and large in comparison of the fixed stars, because we keep constantly near the sun, in comparison of our immense distance from the stars. For a spectator, placed as near to any star as we are to the sun, would see that star a body as large and bright as the sun appears to us: and a spectator, as far distant from the sun as we are from the stars, would see the sun as small as we see a star, divested of all its circumvolving planets; and would reckon it one of the stars in numbering them.

The stars, being at such immense distances from the sun, cannot possibly receive from him so strong a light as they seem to have: nor any brightness sufficient to make them visible to us. For the sun's rays must be so scattered and dissipated before they reach such remote objects, that

they can never be transmitted back to our eyes, so as to render these objects visible by reflexion. The stars therefore shine with their own native and unborrowed lustre, as the sun does; and since each particular star, as well as the sun, is confined to a particular portion of space, it is plain that the stars are of the same nature with the sun.

It is noways probable that the Almighty, who always acts with infinite wisdom, and does nothing in vain, should create so many glorious suns, fit for so many important purposes, and place them at such distances from one another, without proper objects near enough to be benefited by their influences. Whoever imagines they were created only to give a faint glimmering light to the inhabitants of this globe, must have a very superficial knowledge of astronomy, and a mean opinion of the Divine Wisdom; since, by an infinitely less exertion of creating power, the Deity could have given our earth much more light by one single additional moon.

Instead then of one sun and one world only in the universe, astronomy discovers to us such an inconceivable number of suns, systems, and worlds, dispersed through boundless space, that if our sun, with all the planets, moons, and comets belonging to it, were annihilated, they would be no more missed, by an eye that could take in the whole creation, than a grain of sand from the sea-shore: The space they possess being comparatively so small, that it would scarce be a sensible blank in the universe, although Saturn, the outermost of our planets, revolves about the sun in an orbit of 4884 millions of miles in circumference, and some of our comets make excursions upwards of ten thousand millions of miles beyond Saturn's orbit; and yet, at that amazing distance, they are incomparably nearer to the sun than to any of the stars; as is evident from their keeping clear of the attractive power of all the stars, and returning periodically by virtue of the sun's attraction.

From what we know of our own system, it may be reasonably concluded, that all the rest are with equal wisdom contrived, situated, and provided with accommodations for rational inhabitants. Let us therefore take a survey of the system to which we belong; the only one accessible to us; and from thence we shall be the better enabled to judge of the nature and end of the other systems of the universe. For although there is almost an infinite variety in the parts of the creation which we have opportunities of examining, yet there is a general analogy running through, and connecting all the parts into one great and universal system.

To an attentive considerer, it will appear highly probable, that the planets of our system, together with their attendants called *satellites* or *moons*, are much of

the same nature with our earth, and destined for the like purposes. For they are solid opaque globes, capable of supporting animals and vegetable. Some of them are larger, some less, and some much about the size of our earth. They all circulate round the sun, as the earth does, in a shorter or longer time, according to their respective distances from him; and have, where it would not be inconvenient, regular returns of summer and winter, spring and autumn. They have warmer and colder climates, as the various productions of our earth require: And, in such as afford a possibility of discovering it, we observe a regular motion round their axes like that of our earth, causing an alternate return of day and night; which is necessary for labour, rest, and vegetation, and that all parts of their surfaces may be exposed to the rays of the sun.

Such of the planets as are farthest from the sun, and therefore enjoy least of his light, have that deficiency made up by several moons, which constantly accompany and revolve about them, as our moon revolves about the earth. The remotest planet has, over and above, a broad ring encompassing it; which like a lucid zone in the heavens reflects the sun's light very copiously on that planet; so that if the remoter planets have the sun's light fainter by day than we, they have an addition made to it morning and evening by one or more of their moons, and a greater quantity of light in the night-time.

On the surface of the moon, because it is nearer us than any other of the celestial bodies are, we discover a nearer resemblance of our earth. For, by the assistance of telescopes, we observe the moon to be full of high mountains, large valleys, and deep cavities. These similarities leave us no room to doubt; but that all the planets and moons in the system are designed as commodious habitations for creatures endued with capacities of knowing and adoring their beneficent Creator.

Since the fixed stars are prodigious spheres of fire like our sun, and at inconceivable distances from one another as well as from us, it is reasonable to conclude they are made for the same purposes that the sun is; each to bestow light, heat, and vegetation, on a certain number of inhabited planets, kept by gravitation within the sphere of its activity.

## CHAP. II. Of the SOLAR SYSTEM.

THE planets and comets which move round the sun as their centre, constitute the Solar System. Those planets which are near the sun not only finish their circuits sooner, but likewise move faster in their respective orbits, than those which are more remote from him. Their motions are all performed from west to east, in orbits nearly circular. Their names, distances, bulks, and periodical revolutions, are as follow.

THE SUN ☉, an immense globe of fire, is placed near the common centre, or rather in the lower focus, of the orbits of all the planets and comets; and turns round his axis in 25 days 6 hours, as is evident by the motion of spots seen on his surface. His diameter is computed to be 763,000 miles; and, by the various attractions of the

circumvolving planets, he is agitated by a small motion round the centre of gravity of the system. All the planets, as seen from him, move the same way, and according to the order of signs in the graduated circle ♄ ♃ ♀ ♁ ♀ ♁ ♃ ♄, &c. Plate XL. fig. 2. which represents the great ecliptic in the heavens: But, as seen from any one planet, the rest appear sometimes to go backward, sometimes forward, and sometimes to stand still; not in circles nor ellipses, but in looped curves which never return into themselves. The comets come from all parts of the heavens, and move in all sorts of directions.

The axis of a planet is a line conceived to be drawn through its centre, about which it revolves as on a real axis. The extremities of this line, terminating in opposite points of the planet's surface, are called its *poles*. That which points towards the northern part of the heavens, is called the *north pole*; and the other, pointing towards the southern part, is called the *south pole*. A bowl whirled from one's hand into the open air turns round such a line within itself, whilst it moves forward; and such are the lines we mean, when we speak of the axes of the heavenly bodies.

Let us suppose the earth's orbit to be a thin, even, solid plane; cutting the sun through the centre, and extended out as far as the starry heavens, where it will mark the great circle called the *ecliptic*. This circle we suppose to be divided into 12 equal parts, called *signs*; each sign into 30 equal parts, called *degrees*; each degree into 60 equal parts, called *minutes*; and every minute into 60 equal parts, called *seconds*: So that a second is the 60th part of a minute; a minute the 60th part of a degree; and a degree the 360th part of a circle, or 30th part of a sign. The planes of the orbits of all the other planets likewise cut the sun in halves; but, extended to the heavens, form circles different from one another, and from the ecliptic; one half of each being on the north side, and the other on the south side of it. Consequently the orbit of each planet crosses the ecliptic in two opposite points, which are called the planet's *nodes*. These nodes are all in different parts of the ecliptic; and therefore, if the planetary tracks remained visible in the heavens, they would in some measure resemble the different ruts of waggon-wheels crossing one another in different parts, but never going far asunder. That node, or intersection of the orbit of any planet with the earth's orbit, from which the planet ascends northward above the ecliptic, is called the *ascending node* of the planet; and the other, which is directly opposite thereto, is called its *descending node*. Saturn's ascending node is in 21 deg. 13 min. of Cancer ♋; Jupiter's in 7 deg. 29 min. of the same sign, Mars's in 17 deg. 17 min. of Taurus ♉; Venus's in 13 deg. 59 min. of Gemini II, and Mercury's in 14 deg. 43 min. of Taurus. Here we consider the earth's orbit as the standard, and the orbits of all the other planets as oblique to it.

When we speak of the planets orbits, all that is meant is their paths through the open and unresisting space in which they move, and are kept in, by the attractive power of the sun, and the projectile force impressed up-

on them at first; between which power and force there is so exact an adjustment, that they continue in the same tracks without any solid orbits to confine them.

MERCURY, the nearest planet to the sun, goes round him (as in a circle marked ☿, Plate XXXIX. fig. 1.) in 87 days 23 hours of our time nearly; which is the length of his year. But, being seldom seen, and no spots appearing on his surface or disk, the time of his rotation on his axis, or the length of his days and nights, is as yet unknown. His distance from the sun is computed to be 32 millions of miles, and his diameter 2600. In his course round the sun, he moves at the rate of 95 thousand miles every hour. His light and heat from the sun are almost seven times as great as ours; and the sun appears to him almost seven times as large as to us. The great heat on this planet is no argument against its being inhabited; since the Almighty could as easily suit the bodies and constitutions of its inhabitants to the heat of their dwelling, as he has done ours to the temperature of our earth. And it is very probable that the people there have such an opinion of us, as we have of the inhabitants of Jupiter and Saturn; namely, that we must be intolerably cold, and have very little light at so great a distance from the sun.

This planet appears to us with all the various phases of the moon, when viewed at different times by a good telescope; excepting only that he never appears quite full, because his enlightened side is never turned directly towards us but when he is so near the sun as to be lost to our sight in its beams. And, as his enlightened side is always toward the sun, it is plain that he shines not by any light of his own; for if he did, he would constantly appear round. That he moves about the sun in an orbit within the earth's orbit is also plain, (as will be shewn afterwards), because he is never seen opposite to the sun, nor above 56 times the sun's breadth from his centre.

His orbit is inclined seven degrees to the ecliptic; and that node from which he ascends northward above the ecliptic is in the 14th degree of Taurus; the opposite, in the 14th degree of Scorpio. The earth is in these points on the 6th of November and 4th of May, new style; and when Mercury comes to either of his nodes at his inferior conjunction about these times, he will appear to pass over the disk or face of the sun, like a dark, round spot; but in all other parts of his orbit his conjunctions are invisible, because he either goes above or below the sun.

Mr Whiston has given us an account of several periods at which Mercury may be seen on the sun's disk, viz. in the year 1782, Nov. 12th, at 3 h. 44 m. in the afternoon; 1786, May 4th, at 6 h. 57 m. in the forenoon; 1789, Dec. 6th, at 3 h. 55 min. in the afternoon; and 1799, May 7th, at 2 h. 34 m. in the afternoon. There will be several intermediate transits, but none of them visible to us.

VENUS, the next planet in order, is computed to be 59 millions of miles from the sun; and by moving at the rate of 69 thousand miles every hour in her orbit, (as in the circle marked ♀), she goes round the sun in 224

days 17 hours of our time nearly. But though this be the full length of her year, as she performs only  $9\frac{1}{2}$  revolutions on her own axis in that time, her year consists only of  $9\frac{1}{2}$  days; so that in her, every day and night together is as long as 24 $\frac{1}{2}$  days and nights with us. This odd quarter of a day in every year makes every fourth year a leap-year to Venus; as the like does to our earth. Her diameter is 7906 miles; and by her diurnal motion the inhabitants about her equator are carried 43 miles every hour, besides the 69,000 above mentioned.

Her orbit includes that of Mercury within it; for at her greatest elongation, or apparent distance from the sun, she is 96 times his breadth from his centre; which is almost double of Mercury's. Her orbit is included by the earth's; for if it were not, she might be seen as often in opposition to the sun, as she is in conjunction with him; but she was never seen 90 degrees, or a fourth part of a circle, from the sun.

When Venus appears west of the sun, she rises before him in the morning, and is called the *morning-star*; when she appears east of the sun, she shines in the evening after he sets, and is then called the *evening-star*; being each in its turn for 290 days. It may perhaps be surprising at first, that Venus should keep longer on the east or west of the sun, than the whole time of her period round him. But the difficulty vanishes when we consider, that the earth is all the while going round the sun the same way, though not so quick as Venus; and therefore her relative motion to the earth must in every period be as much slower than her absolute motion in her orbit, as the earth during that time advances forward in the ecliptic, which is 220 degrees. To us she appears, through a telescope, in all the various shapes of the moon.

The axis of Venus is inclined 75 degrees to the axis of her orbit; which is  $51\frac{1}{2}$  degrees more than our earth's axis is inclined to the axis of the ecliptic; and therefore her seasons vary much more than ours do. The north pole of her axis inclines toward the 20th degree of aquarius, our earth's to the beginning of Cancer; consequently the northern parts of Venus have summer in the signs where those of our earth have winter, and *vice versa*.

The artificial day at each pole of Venus is as long as  $112\frac{1}{2}$  natural days on our earth.

The sun's greatest declination on each side of her equator amounts to 75 degrees; therefore her tropics are only 15 degrees from her poles, and her polar circles as far from her equator. Consequently, the tropics of Venus are between her polar circles and her poles; contrary to what those of our earth are.

As her annual revolution contains only  $9\frac{1}{2}$  of her days, the sun will always appear to go through a whole sign, or twelfth part of her orbit, in little more than three quarters of her natural day, or nearly in  $18\frac{1}{2}$  of our days and nights.

Because her day is so great a part of her year, the sun changes his declination in one day so much, that if he passes vertically, or directly over head of any given place on the tropic, the next day he will be 26 degrees from



from it; and whatever place he passes vertically over; when in the equator, one day's revolution will remove him  $36\frac{1}{2}$  degrees from it. So that the sun changes his declination every day in Venus about 14 degrees more at a mean rate, than he does in a quarter of a year on our earth. This appears to be providentially ordered, for preventing the too great effects of the sun's heat, (which is twice as great on Venus as on the earth), so that he cannot shine perpendicularly on the same places for two days together; and by that means the heated places have time to cool.

If the inhabitants about the north pole of Venus fix their south or meridian line through that part of the heavens where the sun comes to his greatest height, or north declination, and call those the east and west points of their horizon, which are 90 degrees on each side from that point where the horizon is cut by the meridian line, these inhabitants will have the following remarkable things.

The sun will rise  $22\frac{1}{2}$  degrees north of the east; and going on  $112\frac{1}{2}$  degrees, as measured on the plane of the horizon, he will cross the meridian at an altitude of  $12\frac{1}{2}$  degrees; then making an entire revolution without setting, he will cross it again at an altitude of  $48\frac{1}{2}$  degrees; at the next revolution he will cross the meridian as he comes to his greatest height and declination, at the altitude of 75 degrees; being then only 15 degrees from the zenith, or that point of the heavens which is directly over head; and thence he will descend in the like spiral manner, crossing the meridian first at the altitude of  $48\frac{1}{2}$  degrees; next at the altitude of  $12\frac{1}{2}$  degrees; and going on thence  $112\frac{1}{2}$  degrees, he will set  $22\frac{1}{2}$  degrees north of the west; so that, after having been  $4\frac{1}{2}$  revolutions above the horizon, he descends below it to exhibit the like appearances at the south pole.

At each pole, the sun continues half a year without setting in summer, and as long without rising in winter; consequently the polar inhabitants of Venus have only one day and one night in the year, as it is at the poles of our earth. But the difference between the heat of summer and cold of winter, or of mid-day and mid-night, on Venus, is much greater than on the earth; because in Venus, as the sun is for half a year together above the horizon of each pole in its turn, so he is for a considerable part of that time near the zenith; and during the other half of the year always below the horizon, and for a great part of that time at least 70 degrees from it. Whereas, at the poles of our earth, although the sun is for half a year together above the horizon, yet he never ascends above, nor descends below it, more than  $23\frac{1}{2}$  degrees. When the sun is in the equinoctial, or in that circle which divides the northern half of the heavens from the southern, he is seen with one half of his disk above the horizon of the north pole, and the other half above the horizon of the south pole; so that his centre is in the horizon of both poles: and then descending below the horizon of one, he ascends gradually above that of the other. Hence, in a year, each pole has one spring, one harvest, a summer as long as them both, and a winter equal in length to the other three seasons.

At the polar circles of Venus, the seasons are much the same as at the equator, because there are only 15 degrees betwixt them; only the winters are not quite so long, nor the summers so short; but the four seasons come twice round every year.

At Venus's tropics, the sun continues for about fifteen of our weeks together without setting in summer, and as long without rising in winter. Whilst he is more than 15 degrees from the equator, he neither rises to the inhabitants of the one tropic, nor sets to those of the other; whereas, at our terrestrial tropics, he rises and sets every day of the year.

At Venus's tropics, the seasons are much the same as at her poles; only the summers are a little longer, and the winters a little shorter.

At her equator, the days and nights are always of the same length, and yet the diurnal and nocturnal arches are very different, especially when the sun's declination is about the greatest; for then his meridian altitude may sometimes be twice as great as his midnight depression, and at other times the reverse. When the sun is at his greatest declination, either north or south, his rays are as oblique at Venus's equator, as they are at London on the shortest day of winter. Therefore, at her equator there are two winters, two summers, two springs, and two autumns every year. But because the sun stays for some time near the tropics, and passes so quickly over the equator, every winter there will be almost twice as long as summer; the four seasons returning twice in that time, which consists only of  $9\frac{1}{2}$  days.

Those parts of Venus which lie between the poles and tropics, and between the tropics and polar circles, and also between the polar circles and equator, partake more or less of the phenomena of these circles as they are more or less distant from them.

From the quick change of the sun's declination it happens, that if he rises due east on any day, he will not set due west on that day, as with us; for if the place where he rises due east be on the equator, he will set on that day almost west-north-west, or about  $18\frac{1}{2}$  degrees north of the west. But if the place be in 45 degrees north latitude, then on the day that the sun rises due east he will set north-west by west, or 33 degrees north of the west, and in 62 degrees north latitude. When he rises in the east, he sets not in that revolution, but just touches the horizon 10 degrees to the west of the north point, and ascends again, continuing for  $3\frac{1}{2}$  revolutions above the horizon without setting. Therefore, no place has the forenoon and afternoon of the same day equally long, unless it be in the equator, or at the poles.

The sun's altitude at noon, or at any other time of the day, and his amplitude at rising and setting, being very different at places on the same parallel of latitude, according to the different longitudes of those places, the longitude will be almost as easily found on Venus as the latitude is found on the earth; which is an advantage we can never enjoy, because the daily change of the sun's declination is by much too small for that important purpose.

On this planet, where the sun crosses the equator in any year, he will have 9 degrees of declination from that

place on the same day and hour next year, and will cross the equator 90 degrees farther to the west; which makes the time of the equinox a quarter of a day (or about six of our days) later every year. Hence, although the spiral in which the sun's motion is performed, be of the same sort every year, yet it will not be the very same, because the sun will not pass vertically over the same places till four annual revolutions are finished.

Venus's orbit is inclined  $3\frac{1}{2}$  degrees to the earth's; and crosses it in the 14th degree of Gemini and of Sagittarius; and therefore, when the earth is about these points of the ecliptic at the time that Venus is in her inferior conjunction, she will appear like a spot on the sun, and afford a more certain method of finding the distances of all the planets from the sun, than any other yet known. But these appearances happen very seldom. The first was in the year 1639. The second in the year 1761, June 6. In the morning of that day, when the sun rose at London, Venus had passed both the external and internal contacts. At 38 minutes 21 seconds past 7 o'clock, (apparent time) at Greenwich, the Rev. Dr Bliss, astronomer royal, first saw Venus on the sun; at which instant, the centre of Venus preceded the sun's centre, by  $6' 18'' .9$  of right ascension, and was south of the sun's centre by  $18' 42'' .1$  of declination.—From that time to the beginning of egress, the Doctor made several observations, both of the difference of right ascension and declination of the centres of the sun and Venus; and at last found the beginning of egress, or instant of the internal contact of Venus with the sun's limb, to be at 8 hours 19 minutes 0 seconds apparent time.—From the Doctor's own observations, and those which were made at Shirburn by another gentleman, he has computed, that the mean time at Greenwich of the ecliptical conjunction of the sun and Venus was at 51 minutes 20 seconds after 5 o'clock in the morning; that the place of the sun and Venus was Gemini  $15^{\circ} 36' 33''$ ; that the geocentric latitude of Venus was  $9' 44'' .9$  south,—her horary motion from the sun  $3' 57'' .13$  retrograde, and the angle then formed by the axis of the equator and the axis of the ecliptic was  $6^{\circ} 9' 34''$ , decreasing hourly 1 minute of a degree.—By the mean of three good observations, the diameter of Venus on the sun was  $58''$ .

Mr Short made his observations at Savile-house, in London, 30 seconds in time west from Greenwich, in presence of his royal highness the duke of York, accompanied by their royal highnesses prince William, prince Henry, and prince Frederick.—He first saw Venus on the sun, through flying clouds, at 46 minutes 37 seconds after 5 o'clock; and at 6 hours 15 minutes 12 seconds he measured the diameter of Venus  $59'' .8$ .—He afterward found it to be  $58'' .9$ , when the sky was more favourable.—And, through a reflecting telescope of two feet focus, magnifying 140 times, he found the internal contact of Venus with the sun's limb to be at 8 hours 18 minutes  $21\frac{1}{2}$  seconds, apparent time; which being reduced to the apparent time at Greenwich, was 8 hours 18 minutes  $51\frac{1}{2}$  seconds; so that his time of seeing the contact was  $8\frac{1}{2}$  seconds sooner (in absolute time) than the instant of its being seen at Greenwich.

Messrs Ellicott and Dollond observed the internal con-

tact at Hackney; and their time of seeing it, reduced to the time at Greenwich, was at 8 hours 18 minutes 56 seconds, which was 4 seconds sooner in absolute time than the contact was seen at Greenwich.

Mr Canton in Spittle-Square, London,  $4' 11''$  west of Greenwich, (equal to 16 seconds  $44$  thirds of time), measured the sun's diameter  $31' 33'' 24'''$ , and the diameter of Venus on the sun  $58''$ ; and, by observation, found the apparent time of the internal contact of Venus with the sun's limb to be at 8 hours 18 minutes 41 seconds; which, by reduction, was only  $2\frac{1}{2}$  seconds short of the time at the Royal Observatory at Greenwich.

The Reverend Mr Richard Haydon, at Leskeard in Cornwall, (16 minutes 10 seconds in time west from London, as stated by Dr Bevis), observed the internal contact to be at 8 hours 0 minutes 20 seconds, which, by reduction, was 8 hours 16 minutes 30 seconds at Greenwich; so that he must have seen it 2 minutes 30 seconds sooner in absolute time than it was seen at Greenwich;—a difference by much too great to be occasioned by the difference of parallaxes. But by a memorandum of Mr Haydon's some years before, it appears that he then supposed his west longitude to be near two minutes more; which brings his time to agree within half a minute of the time at Greenwich; to which the parallaxes will very nearly answer.

At Stockholm Observatory, latitude  $59^{\circ} 20\frac{1}{4}'$  north, and longitude 1 hour 12 minutes east from Greenwich, the whole of the transit was visible: the total ingress was observed by Mr Wargentin to be at 3 hours 39 minutes 23 seconds in the morning, and the beginning of egress at 9 hours 30 minutes 8 seconds; so that the whole duration between the two internal contacts, as seen at that place, was 5 hours 50 minutes 45 seconds.

At Torneo in Lapland, (1 hour 27 minutes 28 seconds east of Paris), Mr Hellant, who is esteemed a very good observer, found the total ingress to be at 4 hours 3 minutes 59 seconds, and the beginning of egress to be 9 hours 54 minutes 8 seconds.—So that the whole duration between the two internal contacts was 5 hours 50 minutes 9 seconds.

At Hernosand in Sweden, (latitude  $6^{\circ} 38'$  north, and longitude 1 hour 2 minutes 12 seconds east of Paris), Mr Gilder observed the total ingress to be at 3 hours 38 minutes 26 seconds; and the beginning of egress to be at 9 hours 29 minutes 21 seconds;—the duration between these two internal contacts 5 hours 50 minutes 56 seconds.

Mr De La Lande, at Paris, observed the beginning of egress to be at 8 hours 28 minutes 26 seconds apparent time.—But Mr Ferner (who was then at Conflans,  $14\frac{1}{2}'$  west of the Royal Observatory at Paris) observed the beginning of egress to be at 8 hours 28 minutes 29 seconds true time. The equation, or difference between the true and apparent time, was 1 minute 54 seconds.—The total ingress, being before the sun rose, could not be seen.

At Tobolsk in Siberia, Mr Chappe observed the total ingress to be at 7 hours 0 minutes 28 seconds in the morning, and the beginning of egress to be at 49 minutes  $20\frac{1}{2}$  seconds after 12 at noon.—So that the whole duration of the transit between the internal contacts was 5 hours

hours 48 minutes  $32\frac{1}{2}$  seconds, as seen at that place; which was 2 minutes  $3\frac{1}{2}$  seconds less than as seen at Herneford in Sweden.

At Madras, the Reverend Mr Hirst observed the total ingress to be at 7 hours 47 minutes 55 seconds apparent time in the morning, and the beginning of egress at 1 hour 39 minutes 38 seconds past noon.—The duration between these two internal contacts was 5 hours 51 minutes 43 seconds.

Professor Mathenci at Bologna observed the beginning of egress to be at 9 hours 4 minutes 58 seconds.

At Calcutta, (latitude  $22^{\circ} 30'$  north, nearly  $92^{\circ}$  east longitude from London), Mr William Magee observed the total ingress to be at 8 hours 20 minutes 58 seconds in the morning, and the beginning of egress to be at 2 hours 11 minutes 34 seconds in the afternoon; the duration between the two internal contacts 5 hours 50 minutes 36 seconds.

At the Cape of Good Hope, (1 hour 13 minutes 35 seconds east from Greenwich), Mr Malon observed the beginning of egress to be at 9 hours 39 minutes 50 seconds in the morning.

All these times are collected from the observers accounts, printed in the Philosophical Transactions for the years 1762 and 1763, in which there are several other accounts that are not transcribed.—The instants of Venus's total exit from the sun are likewise mentioned, but they are here left out, as not of any use for finding the sun's parallax.

Whoever compares these times of the internal contacts, as given in by different observers, will find such differences among them, even those which were taken upon the same spot, as will shew, that the instant of either contact could not be so accurately perceived by the observers as Dr Halley thought it could; which probably arises from the difference of peoples eyes, and the different magnifying powers of those telescopes through which the contacts were seen.—If all the observers had made use of equal magnifying powers, there can be no doubt but that the times would have more nearly coincided; since it is plain, that supposing all their eyes to be equally quick and good, they whose telescopes magnified most would perceive the point of internal contact soonest, and of the total exit latest.

Mr Short, in a paper published in the Philosophical Transactions, Vol. LII. Part II. has taken an incredible deal of pains in deducing the quantity of the sun's parallax, from the best of those observations which were

made both in Britain and abroad; and finds it to have been  $8''.52$  on the day of the transit when the sun was very nearly at his greatest distance from the earth; and consequently  $8''.65$  when the sun is at his mean distance from the earth.

The log. sine (or tangent) of  $8''.65$  is 5.6219140, which being subtracted from the radius 10.0000000, leaves remaining the logarithm 4.3780860, whose number is 23882.84; which is the number of semidiameters of the earth that the sun is distant from it.—And this last number, 23882.84, being multiplied by 3985, the number of English miles contained in the earth's semidiameter, gives 95,173,117 miles from the earth's mean distance from the sun.—But because it is impossible, from the nicest observations of the sun's parallax, to be sure of his true distance from the earth within 100 miles, we shall at present, for the sake of round numbers, state the earth's mean distance from the sun at 95,173,000 English miles.

And then, from the numbers and analogies in § 11. & 14. of Mr Short's dissertation, we find the mean distances of all the rest of the planets from the sun, in miles, to be as follows.—Mercury's distance, 36,841,468; Venus's distance, 68,891,486; Mars's distance, 145,014,148; Jupiter's distance, 494,990,976; and Saturn's distance, 907,956,130.

The semidiameter of the earth's annual orbit being equal to the earth's mean distance from the sun, viz. 95,173,000 miles, the whole diameter thereof is 190,346,000 miles. And since the circumference of a circle is to its diameter as 355 is to 113, the circumference of the earth's orbit is 597,989,646 miles.

And, as the earth describes this orbit in 365 days 6 hours (or in 8766 hours) it is plain that it travels at the rate of 68,216.9 miles every hour, and consequently 1136.9 miles every minute; so that its velocity in its orbit is at least 142 times as great as the velocity of a cannon-ball, supposing the ball to move through 8 miles in a minute, which it is found to do very nearly: And at this rate it would take 22 years 228 days for a cannon-ball to go from the earth to the sun.

On the 3d of June, in the year 1769, Venus again passed over the sun's disk, in such a manner, as to afford a much easier and better method of investigating the sun's parallax than her transit in the year 1761. But as few of the observations upon this transit have as yet been made public, we can only give the following, made by different observers at London.

	External contact.		Regular circumferences in contact.		Thread of light completed, or the internal contact.		Telescopes made use of.	Magnifying power.
	h.	" "	h.	" "	h.	" "		
N. Maskelyne,	7	10 58	7	28 31	7	29 23	2 feet reflector,	140
M. Hitchens,	7	10 54	7	28 47	7	28 57	6 f. reflector,	90
W. Hirst,	7	11 11			7	29 18	2 f. reflector,	55
J. Horsley,	7	10 44	7	28 15	7	29 28	10 f. achromatic,	50
S. Dunn,	7	10 37	7	29 28	7	29 48	$3\frac{1}{2}$ f. achromatic,	140
P. Dollond,	7	11 19			7	29 20	$3\frac{1}{2}$ f. achromatic,	150
E. Nairne,	7	11 30			7	29 20	2 f. reflector,	120

When

When Venus was little more than half emerged into the sun's disk. Mr Maskelyne saw her whole circumference completed, by means of a vivid, but narrow and ill defined border of light, which illuminated that part of her circumference which was off the sun, and otherwise not visible. They all observed the black protuberance in the internal contact. They likewise, after the internal contact, saw a luminous ring round the body of Venus, about the thickness of half her semi-diameter; it was brightest towards Venus's body, and gradually diminished in splendor at greater distance, but the whole was excessive white and faint.

Venus may have a satellite or moon, although it be undiscovered by us: which will not appear very surprising, if we consider how inconveniently we are placed from seeing it. For its enlightened side can never be fully turned towards us, but when Venus is beyond the sun; and then, as Venus appears little bigger than an ordinary star, her moon may be too small to be perceived at such a distance. When she is between us and the sun, her full moon has its dark side towards us; and then we cannot see it any more than we can our own moon at the time of change. When Venus is at her greatest elongation, we have but one half of the enlightened side of her full moon towards us; and even then it may be too far distant to be seen by us.

THE EARTH is the next planet above Venus in the system. It is 82 millions of miles from the sun, and goes round him (as in the circle  $\odot$ ) in 365 days 5 hours 49 minutes, from any equinox or solstice to the same again; but from any fixed star to the same again, as seen from the sun, in 365 days 6 hours and 9 minutes; the former being the length of the tropical year, and the latter the length of the syderial. It travels the rate of 58 thousand miles every hour; which motion, though 120 times swifter than that of a cannon-ball, is little more than half as swift as Mercury's motion in his orbit. The earth's diameter is 7970 miles; and by turning round its axis every 24 hours from west to east, it causes an apparent diurnal motion of all the heavenly bodies from east to west. By this rapid motion of the earth on its axis, the inhabitants about the equator are carried 1042 miles every hour, whilst those on the parallel of London are carried only about 580, besides the 58 thousand miles by the annual motion above mentioned, which is common to all places whatever.

The earth's axis makes an angle of  $23\frac{1}{2}$  degrees with the axis of its orbit, and keeps always the same oblique direction, inclining towards the same fixed stars throughout its annual course, which causes the returns of spring, summer, autumn, and winter; as will be explained afterwards.

The earth is round like a globe; as appears, 1. By its shadow in eclipses of the moon, which shadow is always bounded by a circular ring. 2. By our seeing the masts of a ship whilst the hull is hid by the convexity of the water. 3. By its having been sailed round by many navigators. The hills take off no more from the roundness of the earth in comparison, than grains of dust do from the roundness of a common globe.

The seas and unknown parts of the earth (by a mea-

surement of the best maps) contain 160 million 522 thousand and 26 square miles; the inhabited parts 38 million 990 thousand 569: Europe 4 million 456 thousand and 65; Asia, 10 million 768 thousand 823; Africa, 9 million 654 thousand 807; America, 14 million 110 thousand 874. In all, 199 million 512 thousand 595; which is the number of square miles on the whole surface of our globe.

The MOON is not a planet, but only a satellite or attendant of the earth; going round the earth from change to change in 29 days 12 hours and 44 minutes; and round the sun with it every year. The moon's diameter is 2180 miles; and her distance from the earth's centre 240 thousand. She goes round her orbit in 27 days 7 hours 43 minutes, moving about 2290 miles every hour; and turns round her axis exactly in the same time that she goes round the earth, which is the reason of her keeping always the same side towards us, and that her day and night, taken together, is as long as our lunar month.

The moon is an opaque globe like the earth, and shines only by reflecting the light of the sun: Therefore whilst that half of her which is toward the sun is enlightened, the other half must be dark and invisible. Hence, she disappears when she comes between us and the sun; because her dark side is then towards us. When she is gone a little way forward, we see a little of her enlightened side; which still encreases to our view, as she advances forward, until she comes to be opposite the sun; and then her whole enlightened side is towards the earth, and she appears with a round, illumined orb, which we call the *full moon*; her dark side being then turned away from the earth. From the full she seems to decrease gradually as she goes through the other half of her course; shewing us less and less of her enlightened side every day, till her next change or conjunction with the sun, and then she disappears as before.

This continual change of the moon's phases demonstrates that she shines not by any light of her own; for if she did, being globular, we should always see her with a round full orb like the sun. Her orbit is represented in the scheme by the little circle *m*, upon the earth's orbit  $\odot$ , Plate XXXIX. fig. 1.; but it is drawn fifty times too large in proportion to the earth's; and yet is almost too small to be seen in the diagram.

The moon has scarce any difference of seasons; her axis being almost perpendicular to the ecliptic. What is very singular, one half of her has no darkness at all; the earth constantly affording it a strong light in the sun's absence; while the other half has a fortnight's darkness, and a fortnight's light by turns.

Our earth is a moon to the moon, waxing and waning regularly, but appearing thirteen times as big, and affording her thirteen times as much light as she does to us. When she changes to us, the earth appears full to her; and when she is in her first quarter to us, the earth is in its third quarter to her; and *vice versa*.

But from one half of the moon, the earth is never seen at all; from the middle of the other half, it is always seen over head; turning round almost thirty times as quick as the moon does. From the circle which limits our view of the moon, only one half of the earth's

side

side next her is seen; the other half being hid below the horizon of all places on that circle. To her the earth seems to be the largest body in the universe, for it appears thirteen times as large as she does to us.

The moon has no atmosphere of any visible density surrounding her; for if she had, we could never see her edge so well defined as it appears; but there would be a sort of a mist or haziness around her, which would make the stars look fainter, when they are seen through it. But observation proves, that the stars which disappear behind the moon retain their full lustre until they seem to touch her very edge, and then they vanish in a moment. The faint light which has been seen all around the moon in total eclipses of the sun, has been observed, during the time of darkness, to have its centre coincident with the centre of the sun; and was therefore much more likely to arise from the atmosphere of the sun than from that of the moon; for if it had been owing to the latter, its centre would have gone along with the moon's.

If there were seas in the moon, she could have no clouds, rains, nor storms, as we have; because she has no such atmosphere to support the vapours which occasion them. And every one knows, that when the moon is above our horizon in the night-time, she is visible, unless the clouds of our atmosphere hide her from our view, and all parts of her appear constantly with the same clear, serene, and calm aspect. But those dark parts of the moon, which were formerly thought to be seas, are now found to be only vast deep cavities, and places which reflect not the sun's light so strongly as others, having many caverns and pits, whose shadows fall within them, and are always dark on the sides next the sun, which demonstrates their being hollow; and most of these pits have little knobs like hillocks standing within them, and casting shadows also; which cause these places to appear darker than others which have fewer or less remarkable caverns. All these appearances shew, that there are no seas in the moon; for if there were any, their surfaces would appear smooth and even, like those on the earth.

There being no atmosphere about the moon, the heavens in the day-time have the appearance of night to a lunarian who turns his back toward the sun; and when he does, the stars appear as bright to him as they do in the night to us. For it is entirely owing to our atmosphere that the heavens are bright about us in the day.

As the earth turns round its axis, the several continents, seas, and islands appear to the moon's inhabitants like so many spots of different forms and brightness, moving over its surface, but much fainter at some times than others, as our clouds cover them or leave them. By these spots, the lunarians can determine the time of the earth's diurnal motion, just as we do the motion of the sun; and perhaps they measure their time by the motion of the earth's spots, for they cannot have a truer dial.

The moon's axis is so nearly perpendicular to the ecliptic, that the sun never removes sensibly from her equator; and the obliquity of her orbit, being only  $5\frac{1}{2}$  degrees, which is next to nothing as seen from the sun, cannot cause the sun to decline sensibly from her equator. Yet her inhabitants are not destitute of means for ascer-

taining the length of their year, though their method and ours must differ. For we can know the length of our year by the return of our equinoxes; but the lunarians, having always equal day and night, must have recourse to another method; and we may suppose, they measure their year by observing when either of the poles of our earth begins to be enlightened, and the other to disappear, which is always at our equinoxes, they being conveniently situated for observing great tracks of land about our earth's poles, which are entirely unknown to us. Hence we may conclude, that the year is of the same absolute length both to the earth and moon, though very different as to the number of days; we having  $365\frac{1}{4}$  natural days, and the lunarians only  $12\frac{7}{8}$ ; every day and night in the moon being as long as  $29\frac{1}{2}$  on the earth.

The moon's inhabitants on the side next the earth may as easily find the longitude of their places as we can find the latitude of ours. For the earth keeping constantly, or very nearly so, over one meridian of the moon, the east or west distances of places from that meridian are as easily found as we can find our distance from the equator by the altitude of our celestial poles.

The planet MARS is next in order, being the first above the earth's orbit. His distance from the sun is computed to be 125 millions of miles; and by travelling at the rate of 47 thousand miles every hour, as in the circle  $\odot$ , he goes round the sun in 686 of our days and 23 hours; which is the length of his year, and contains  $667\frac{1}{2}$  of his days, every day and night together being 40 minutes longer than with us. His diameter is 4444 miles, and by his diurnal rotation the inhabitants about his equator are carried 556 miles every hour. His quantity of light and heat is equal but to one half of ours; and the sun appears but half as big to him as to us.

This planet being but a fifth part so big as the earth, if any moon attends him, she must be very small, and has not yet been discovered by our best telescopes. He is of a fiery red colour, and by his appulses to some of the fixed stars seems to be encompassed by a very gross atmosphere. He appears sometimes gibbous, but never horned; which both shews that his orbit includes the earth's within it, and that he shines not by his own light.

To Mars, our earth and moon appear like two moons, a bigger and a less, changing places with one another, and appearing sometimes horned, sometimes half or three quarters illuminated, but never full, nor at most above one quarter of a degree from each other, although they are 240 thousand miles asunder.

Our earth appears almost as big to Mars as Venus does to us, and at MARS it is never seen above 48 degrees from the sun; sometimes it appears to pass over the disk of the sun, and so do Mercury and Venus; but Mercury can never be seen from Mars by such eyes as ours, unassisted by proper instruments; and Venus will be as seldom seen as we see Mercury. Jupiter and Saturn are as visible to Mars as to us. His axis is perpendicular to the ecliptic, and his orbit is 2 degrees inclined to it.

JUPITER, the largest of all the planets, is still higher in the system, being about 426 millions of miles from the sun; and going at the rate of 25 thousand miles every hour in his orbit, as in the circle  $\mathcal{J}$ , finishes his annual period

Period in eleven of our years 314 days and 12 hours. He is about 1000 times as big as the earth, for his diameter is 81,000 miles; which is more than ten times the diameter of the earth.

Jupiter turns round his axis in 9 hours 56 minutes; so that his year contains 10 thousand 470 days; and the diurnal velocity of his equatorial parts is greater than the swiftness with which he moves in his annual orbit; a singular circumstance, as far as we know. By this prodigious quick rotation, his equatorial inhabitants are carried 25 thousand 920 miles every hour, (which is 920 miles an hour more than an inhabitant of our earth's equator moves in twenty-four hours), besides the 25 thousand above mentioned, which is common to all parts of his surface, by his annual motion.

Jupiter is surrounded by faint substances, called *belts*, in which so many changes appear, that they are generally thought to be clouds; for some of them have been first interrupted and broken, and then have vanished entirely. They have sometimes been observed of different breadths, and afterwards have all become nearly of the same breadth. Large spots have been seen in these belts; and when a belt vanishes, the contiguous spots disappear with it. The broken ends of some belts have been generally observed to revolve in the same time with the spots; only those nearer the equator in somewhat less time than those near the poles, perhaps on account of the sun's greater heat near the equator, which is parallel to the belts and course of the spots. Several large spots, which appear round at one time, grow oblong by degrees, and then divide into two or three round spots. The periodical time of the spots near the equator is 9 hours 50 minutes, but of those near the poles 9 hours 56 minutes.

The axis of Jupiter is so nearly perpendicular to his orbit, that he has no sensible change of seasons; which is a great advantage, and wisely ordered by the Author of nature. For if the axis of this planet were inclined any considerable number of degrees, just so many degrees round each pole would in their turn be almost six of our years together in darkness. And as each degree of a great circle on Jupiter contains 706 of our miles at a mean rate, it is easy to judge what vast tracts of land would be rendered uninhabitable by any considerable inclination of his axis.

The sun appears but  $\frac{1}{11}$  part so big to Jupiter as to us; and his light and heat are in the same small proportion, but compensated by the quick returns thereof, and by four moons (some larger and some less than our earth) which revolve about him; so that there is scarce any part of this huge planet but what is, during the whole night, enlightened by one or more of these moons, except his poles, whence only the farthest moons can be seen, and where their light is not wanted, because the sun constantly circulates in or near the horizon, and is very probably kept in view of both poles by the refraction of Jupiter's atmosphere, which, if it be like ours, has certainly refractive power enough for that purpose.

The orbits of these moons are represented in the scheme of the solar system by four small circles marked 1, 2, 3, 4, on Jupiter's orbit  $\mathcal{J}$ ; but they are drawn fifty

times too large in proportion to it. The first moon, or that nearest to Jupiter, goes round him in 1 day 18 hours and 36 minutes of our time; and is 229 thousand miles distant from his centre; the second performs its revolution in three days 13 hours and 15 minutes, at 364 thousand miles distance; the third in seven days three hours and 59 minutes, at the distance of 580 thousand miles; and the fourth, or outermost, in 16 days 18 hours and 30 minutes, at the distance of one million of miles from his centre. The periods of these moons are so incommensurate to one another, that if ever they were all in a right line between Jupiter and the sun, it will require more than 3,000,000,000,000 years from that time to bring them all into the same right line again, as any one will find who reduces all their periods into seconds, then multiplies them into one another, and divides the product by 432; which is the highest number that will divide the product of all their periodical times, namely, 42,085,303,376,931,994,955,904 seconds, without a remainder.

The angles under which the orbits of Jupiter's moons are seen from the earth, at its mean distance from Jupiter, are as follow: The first,  $3' 55''$ ; the second,  $6' 14''$ ; the third,  $9' 58''$ ; and the fourth,  $17' 30''$ . And their distances from Jupiter, measured by his semi-diameters, are thus: The first,  $5\frac{2}{3}$ ; the second, 9; the third,  $14\frac{2}{3}$ ; and the fourth,  $25\frac{8}{15}$ . This planet, seen from its nearest moon, appears 1000 times as large as our moon does to us; waxing and waning in all her monthly shapes every  $42\frac{1}{2}$  hours.

Jupiter's three nearest moons fall into his shadow, and are eclipsed in every revolution; but the orbit of the fourth moon is so much inclined, that it passeth by its opposition to Jupiter, without falling into his shadow, two years in every six. By these eclipses, astronomers have not only discovered that the sun's light takes up eight minutes of time in coming to us, but they have also determined the longitudes of places on this earth with greater certainty and facility than by any other method yet known.

The difference between the equatorial and polar diameters of Jupiter is 6230 miles; for his equatorial diameter is to his polar, as 13 to 12. So that his poles are 3115 miles nearer his centre than his equator is.

Jupiter's orbit is 1 degree 20 minutes inclined to the ecliptic. His north node is in the 7th degree of Cancer, and his south node in the 7th degree of Capricorn.

SATURN, the remotest of all the planets, is about 780 millions of miles from the sun; and, travelling at the rate of 18 thousand miles every hour, as in the circle marked  $\mathcal{S}$ , performs its annual circuit in 29 years 167 days and 5 hours of our time; which makes only one year to that planet. Its diameter is 67,000 miles; and therefore it is near 600 times as big as the earth.

This planet is surrounded by a thin broad ring, as an artificial globe is by a horizon, fig. 5. The ring appears double when seen through a good telescope, and is represented by the figure in such an oblique view as it is generally seen. It is inclined 30 degrees to the ecliptic, and is about 21 thousand miles in breadth; which is equal to its distance from Saturn on all sides. There is,

reason.

reason to believe that the ring turns round its axis, because, when it is almost edge-wise to us, it appears somewhat thicker on one side of the planet than on the other; and the thickest edge has been seen on different sides at different times. But Saturn having no visible spots on his body, whereby to determine the time of his turning round his axis, the length of his days and nights, and the position of his axis, are unknown to us.

To Saturn, the sun appears only  $\frac{1}{50}$ th part so big as to us; and the light and heat he receives from the sun are in the same proportion to ours. But to compensate for the small quantity of sun-light, he has five moons, all going round him on the outside of his ring, and nearly on the same plane with it. The first, or nearest moon to Saturn, goes round him in 1 day 21 hours 19 minutes; and is 140 thousand miles from his centre: The second, in 2 days 17 hours 40 minutes; at the distance of 187 thousand miles: The third, in 4 days 12 hours 25 minutes, at 263 thousand miles distance: The fourth, in 15 days 22 hours 41 minutes, at the distance of 600 thousand miles: And the fifth or outermost, at one million 800 thousand miles from Saturn's centre, goes round him in 79 days 7 hours 48 minutes. Their orbits, in the scheme of the solar system, are represented by the small five circles, marked 1, 2, 3, 4, 5, on Saturn's orbit; but these, like the orbits of the other satellites, are drawn fifty times too large in proportion to the orbits of their primary planets.

The sun shines almost fifteen of our years together on one side of Saturn's ring without setting, and as long on the other in its turn. So that the ring is visible to the inhabitants of that planet for almost fifteen of our years, and as long invisible by turns, if its axis has no inclination to its ring: But if the axis of the planet be inclined to the ring, suppose about 30 degrees, the ring will appear and disappear once every natural day to all the inhabitants within 30 degrees of the equator, on both sides, frequently eclipsing the sun in a Saturnian day. Moreover, if Saturn's axis be so inclined to his ring, it is perpendicular to his orbit; and thereby the inconvenience of different seasons to that planet is avoided. For considering the length of Saturn's year, which is almost equal to thirty of ours, what a dreadful condition must the inhabitants of his polar regions be in, if they be half that time deprived of the light and heat of the sun? which is not their case alone, if the axis of the planet be perpendicular to the ring, for then the ring must hide the sun from vast tracts of land on each side of the equator for 13 or 14 of our years together, on the south side and north side by turns, as the axis inclines to or from the sun: The reverse of which inconvenience is another good presumptive proof of the inclination of Saturn's axis to its ring, and also of his axis being perpendicular to his orbit.

This ring, seen from Saturn, appears like a vast luminous arch in the heavens; as if it did not belong to the planet. When we see the ring most open, its shadow upon the planet is broadest; and from that time the shadow grows narrower, as the ring appears to do to us; until, by Saturn's annual motion, the sun comes to the plane of the ring, or even with its edge; which being then directed

towards us, becomes invisible on account of its thinness; as shall be explained afterwards. The ring disappears twice in every annual revolution of Saturn, namely, when he is in the 19th degree both of Pisces and of Virgo. And when Saturn is in the middle between these points, or in the 19th degree either of Gemini or of Sagittarius, his ring appears most open to us; and then its longest diameter is to its shortest, as 9 to 4.

To such eyes as ours, unassisted by instruments, Jupiter is the only planet that can be seen from Saturn, and Saturn the only planet that can be seen from Jupiter. So that the inhabitants of these two planets must either see much farther than we do, or have equally good instruments to carry their sight to remote objects, if they know that there is such a body as our earth in the universe: For the earth is no bigger, seen from Jupiter, than his moons are seen from the earth; and if his large body had not first attracted our sight, and prompted our curiosity to view him with the telescope, we should never have known any thing of his moons; unless by chance we had directed the telescope toward that small part of the heavens where they were at the time of observation. And the like is true of the moons of Saturn.

The orbit of Saturn is  $2\frac{1}{2}$  degrees inclined to the ecliptic, or orbit of our earth, and intersects it in the 21st degree of Cancer and of Capricorn; so that Saturn's nodes are only 14 degrees from Jupiter's.

The quantity of light, afforded by the sun to Jupiter, being but  $\frac{1}{17}$ th part, and to Saturn only  $\frac{1}{50}$ th part, of what we enjoy, may, at first thought, induce us to believe that these two planets are entirely unfit for rational beings to dwell upon. But, that their light is not so weak as we imagine, is evident from their brightness in the night-time; and also from this remarkable phenomenon, that when the sun is so much eclipsed to us, as to have only the 40th part of his disk left uncovered by the moon, the decrease of light is not very sensible; and just at the end of darkness in total eclipses, when his western limb begins to be visible, and seems no bigger than a bit of fine silver wire, every one is surprised at the brightness wherewith that small part of him shines. The moon, when full, affords travellers light enough to keep them from mistaking their way; and yet, according to Dr Smith, it is equal to no more than a 90 thousandth part of the light of the sun: That is, the sun's light is 90 thousand times as strong as the light of the moon when full. Consequently, the sun gives a thousand times as much light to Saturn as the full moon does to us; and above three thousand times as much to Jupiter. So that these two planets, even without any moons, would be much more enlightened than we at first imagine; and by having so many, they may be very comfortable places of residence. Their heat, so far as it depends on the force of the sun's rays, is certainly much less than ours; to which no doubt the bodies of their inhabitants are as well adapted as ours are to the seasons we enjoy. And if we consider, that Jupiter never has any winter, even at his poles, which probably is also the case with Saturn, the cold cannot be so intense on these two planets as is generally imagined. Besides, there may be something in their nature or soil much warmer than

than in that of our earth: And we find that all our heat depends not on the rays of the sun; for if it did, we should always have the same months equally hot or cold at their annual returns. But it is far otherwise, for February is sometimes warmer than May; which must be owing to vapours and exhalations from the earth.

Every person who looks upon, and compares the systems of moons together, which belong to Jupiter and Saturn, must be amazed at the vast magnitude of these two planets, and the noble attendance they have in respect of our little earth; and can never bring himself to think, that an infinitely wise Creator should dispose of all his animals and vegetables here, leaving the other planets bare and destitute of rational creatures. To suppose that he had any view to our benefit, in creating these moons, and giving them their motions round Jupiter and Saturn; to imagine that he intended these vast bodies for any advantage to us, when he well knew that they could never be seen but by a few astronomers peeping through telescopes; and that he gave to the planets regular returns of days and nights, and, different seasons to all where they would be convenient; but of no manner of service to us, except only what immediately regards our own planet the earth; to imagine that he did all this on our account, would be charging him impiously with having done much in vain; and as absurd, as to imagine that he has created a little sun and a planetary system within the shell of our earth, and intended them for our use. These considerations amount to little less than a positive proof, that all the planets are inhabited: For if they are not, why all this care in furnishing them with so many moons, to supply those with light which are at the greater distances from the sun? Do we not see, that the farther a planet is from the sun, the greater apparatus it has for that purpose? save only Mars, which being but a small planet, may have moons too small to be seen by us. We know that the earth goes round the sun, and turns round its own axis, to produce the vicissitudes of summer and winter by the former, and of day and night by the latter motion, for the benefit of its inhabitants. May we not then fairly conclude, by parity of reason, that the end and design of all the other planets is the same? and is not this agreeable to the beautiful harmony which exists throughout the universe?

In fig. 2. we have a view of the proportional breadth of the sun's face or disk, as seen from the different planets. The sun is represented, N° 1, as seen from Mercury; N° 2, as seen from Venus; N° 3, as seen from the earth; N° 4, as seen from Mars; N° 5, as seen from Jupiter; and N° 6, as seen from Saturn.

Let the circle *B*, (fig. 3.) be the sun as seen from any planet, at a given distance; to another planet. at double that distance, the sun will appear just of half that breadth, as *A*, which contains only one fourth part of the area, or surface of *B*. For all circles, as well as square surfaces, are to one another as the squares of their diameters. Thus, (fig. 4.) the square *A* is just half as broad as the square *B*; and yet it is plain to sight, that *B* contains four times as much surface as *A*. Hence, by comparing the diameters of the above circles (fig. 2.) together, it will be found, that, in round numbers, the sun appears

7 times larger to Mercury than to us, 90 times larger to us than to Saturn, and 630 times as large to Mercury as to Saturn.

In fig. 5. we have a view of the bulks of the planets in proportion to each other, and to a supposed globe of two feet diameter for the sun. The earth is 27 times as big as Mercury, very little bigger than Venus, five times as big as Mars; but Jupiter is 1049 times as big as the earth; Saturn 586 times as big, exclusive of his ring; and the sun is 877 thousand 650 times as big as the earth. If the planets in this figure were set at their due distances from a sun of two feet diameter, according to their proportional bulks, as in our system, Mercury would be 28 yards from the sun's centre; Venus 51 yards 1 foot; the earth 70 yards 2 feet; Mars 107 yards 2 feet; Jupiter 370 yards 2 feet; and Saturn 760 yards two feet; the comet of the year 1680, at its greatest distance, 10 thousand 760 yards. In this proportion, the moon's distance from the centre of the earth would be only  $7\frac{1}{2}$  inches.

To assist the imagination in forming an idea of the vast distances of the sun, planets, and stars, let us suppose, that a body projected from the sun should continue to fly with the swiftness of a cannon-ball, *i. e.* 480 miles every hour; this body would reach the orbit of Mercury, in 7 years 221 days; of Venus, in 14 years 8 days; of the earth, in 19 years 91 days; of Mars, in 29 years 85 days; of Jupiter, in 100 years 280 days; of Saturn, in 184 years 240 days; to the comet of 1680, at its greatest distance from the sun, in 2660 years; and to the nearest fixed stars, in about 7 million 600 thousand years.

As the earth is not the centre of the orbits in which the planets move, they come nearer to it and go farther from it, and at different times; on which account they appear bigger and less by turns. Hence, the apparent magnitudes of the planets are not always a certain rule to know them by.

Under fig. 3. are the names and characters of the twelve signs of the zodiac, which the reader should be perfectly well acquainted with, so as to know the characters without seeing the names. Every sign contains 30 degrees, as in the circle bounding the solar system; to which the characters of the signs are set in their proper places.

The COMETS are solid opaque bodies, with long transparent trains or tails, issuing from that side which is turned away from the sun. They move about the sun in very excentric ellipses; and are of a much greater density than the earth; for some of them are heated in every period to such a degree, as would vitrify or dissipate any substance known to us. Sir Isaac Newton computed the heat of the comet which appeared in the year 1680, when nearest the sun, to be 2000 times hotter than red-hot iron; and that, being thus heated, it must retain its heat until it comes round again, although its period should be more than twenty thousand years; and it is computed to be only 575.

Part of the paths of three comets are delineated in the scheme of the solar system, and the years marked in which they made their appearance. It is believed that



Fig. 5.



- ♂ Mars
- ♁ Earth & Moon
- ♀ Venus
- ☿ Mercury
- ♃ Jupiter

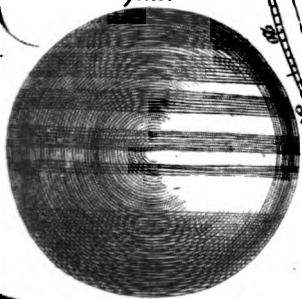


Fig. 1.

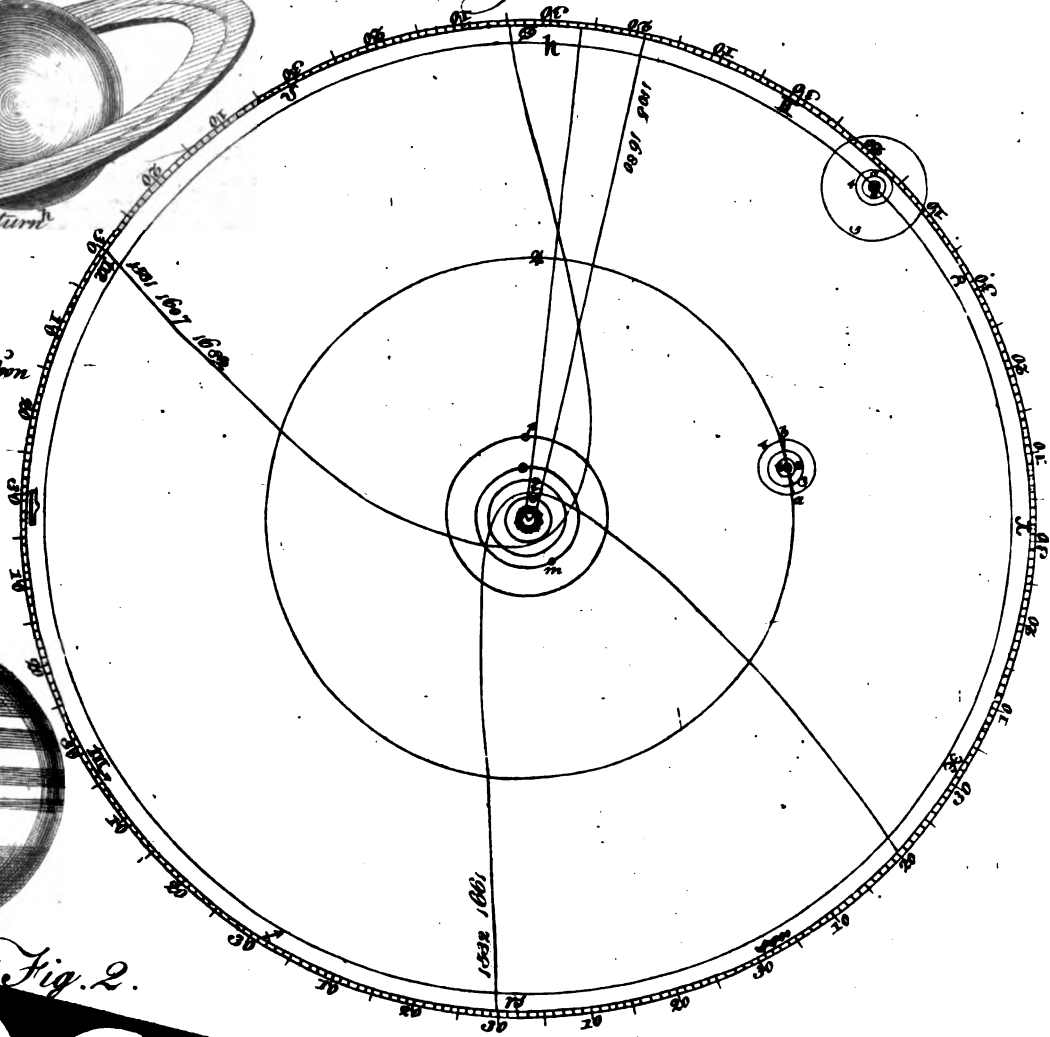


Fig. 2.

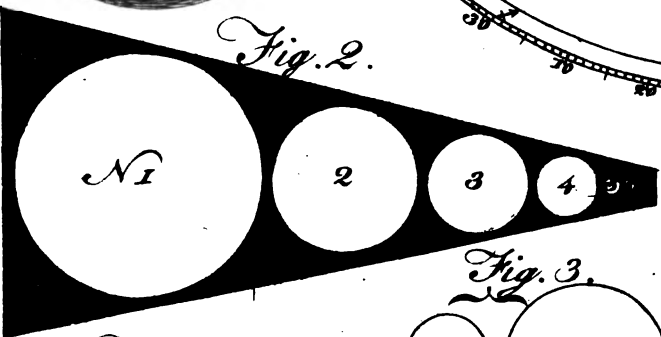
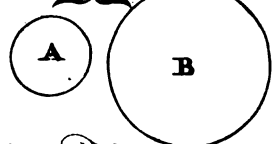


Fig. 3.



Aries ♈	Taurus ♉	Gemini ♊
Cancer ♋	Leo ♌	Virgo ♍
Libra ♎	Scorpio ♏	Sagittarius ♐
Capricornus ♑	Aquarius ♒	Pisces ♓

Fig. 4.

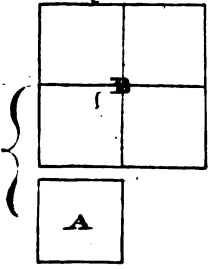
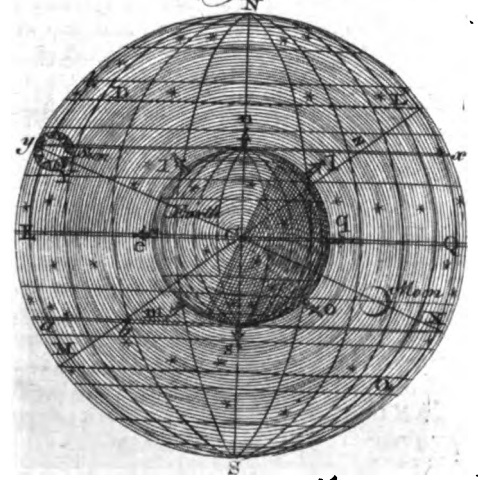


Fig. 6.





that there are at least 21 comets belonging to our system, moving in all sorts of directions; and all those which have been observed, have moved through the ethereal regions and the orbits of the planets without suffering the least sensible resistance in their motions; which plainly proves that the planets do not move in solid orbs. Of all the comets, the periods of the above mentioned three only are known with any degree of certainty. The first of these comets appeared in the years 1531, 1607, and 1682; was expected to appear again in the year 1758, and every 75th year afterwards. The second of them appeared in 1532 and 1661, and may be expected to return in 1789, and every 129th year afterwards. The third, having last appeared in 1680, and its period being no less than 575 years, cannot return until the year 2225. This comet, at its greatest distance, is about 11 thousand two hundred millions of miles from the sun; and at its least distance from the sun's centre, which is 400,000 miles, is within less than a third part of the sun's semi-diameter from his surface. In that part of its orbit which is nearest the sun, it flies with the amazing swiftness of 880,000 miles in an hour; and the sun, as seen from it, appears an hundred degrees in breadth, consequently 40 thousand times as large as he appears to us. The astonishing length that this comet runs out into empty space, suggests to our minds an idea of the vast distance between the sun and the nearest fixed stars; of whose attractions all the comets must keep clear to return periodically, and go round the sun; and it shews us also, that the nearest stars, which are probably those that seem the largest, are as big as our sun, and of the same nature with him; otherwise they could not appear so large and bright to us as they do at such an immense distance.

The extreme heat, the dense atmosphere, the gross vapours, the chaotic state of the comets, seem at first sight to indicate them altogether unfit for the purposes of animal life, and a most miserable habitation for rational beings; and therefore some are of opinion that they are so many hells for tormenting the damned with perpetual vicissitudes of heat and cold. But when we consider, on the other hand, the infinite power and goodness of the Deity, the latter inclining, and the former enabling him to make creatures suited to all states and circumstances; that matter exists only for the sake of intelligent beings; and that where-ever we find it, we always find it pregnant with life, or necessarily subservient thereto; the numberless species, the astonishing diversity of animals in earth, air, water, and even on other animals; every blade of grass, every leaf, every fluid swarming with life; and every one of these enjoying such gratifications as the nature and state of each requires: When we reflect moreover, that some centuries ago, till experience undeceived us, a great part of the earth was judged uninhabitable, the torrid zone by reason of excessive heat, and the frigid zones because of their intolerable cold; it seems highly probable, that such numerous and large masses of durable matter as the comets are, however unlike they be to our earth, are not destitute of beings capable of contemplating with wonder, and acknowledging with gratitude,

the wisdom, symmetry, and beauty of the creation; which is more plainly to be observed in their extensive tour through the heavens, than in our more confined circuit. If farther conjecture is permitted, may we not suppose them instrumental in recruiting the expanded fuel of the sun, and supplying the exhausted moisture of the planets? However difficult it may be, circumstanced as we are, to find out their particular destination, this is an undoubted truth, that where-ever the Deity exerts his power, there he also manifests his wisdom and goodness.

The solar system here described is not a late invention, for it was known and taught by the wise Samian philosopher Pythagoras, and others among the ancients; but in latter times was lost, till the 15th century, when it was again restored by the famous Polish philosopher, Nicholas Copernicus, who was born at Thorn in the year 1473. In this he was followed by the greatest mathematicians and philosophers that have since lived; as Kepler, Galileo, Descartes, Gassendus, and Sir Isaac Newton; the last of whom has established this system on such a foundation of mathematical and physical demonstration, as can never be shaken.

In the Ptolemean system, the earth was supposed to be fixed in the centre of the universe; and that the Moon, Mercury, Venus, the Sun, Mars, Jupiter, and Saturn, moved round the earth: Above the planets this hypothesis placed the firmament of stars, and then the two crystalline spheres; all which were included in and received motion from the *primum mobile*, which constantly revolved about the earth in 24 hours from east to west. But as this rude scheme was found incapable to stand the test of art and observation, it was soon rejected by all true philosophers.

The Tychoenic system succeeded the Ptolemean, but was never so generally received. In this the earth was supposed to stand still in the centre of the universe or firmament of stars, and the sun to revolve about it every 24 hours; the planets, Mercury, Venus, Mars, Jupiter, and Saturn, going round the sun in the times already mentioned. But some of Tycho's disciples supposed the earth to have a diurnal motion round its axis, and the sun, with all the above planets, to go round the earth in a year; the planets moving round the sun in the fore said times. This hypothesis, being partly true, and partly false, was embraced by few; and soon gave way to the only true and rational scheme, restored by Copernicus, and demonstrated by Sir Isaac Newton.

### CHAP. III. *The Phenomena of the Heavens as seen from different Parts of the Earth.*

WE are kept to the earth's surface on all sides by the power of its central attraction; which, laying hold of all bodies according to their densities or quantities of matter, without regard to their bulks, constitutes what we call their *weight*. And having the sky over our heads, go where we will, and our feet towards the centre of the earth, we call it *up* over our heads, and *down* under our feet: Although the same right line which is *down* to us, if continued through, and beyond the opposite side of the

earth, would be *up* to the inhabitants on the opposite side. For, the inhabitants *n, i, e, m, s, o, q, l*, (Plate XXXIX. fig. 6.) stand with their feet towards the earth's centre *C*; and have the same figure of sky, *N, I, E, M, S, O, Q, L* over their heads. Therefore the point *S* is as directly upward to the inhabitant (*s*) on the south pole, as *N* is to the inhabitant *n* on the north pole; so is *E* to the inhabitant *e*, supposed to be on the north end of Peru; and *Q* to the opposite inhabitant *q* on the middle of the island of Sumatra. Each of these observers is surprised that his opposite or antipode can stand with his head hanging downwards. But let either go to the other, and he will tell him that he stood as upright and firm upon the place where he was, as he now stands where he is. To all these observers, the sun, moon, and stars, seem to turn round the points *N* and *S*, as the poles of the fixed axis *NCs*; because the earth does really turn round the mathematical line *nCs* as round an axis, of which *n* is the north pole, and *s* the south pole. The inhabitant *U* (Plate XL. fig. 1.) affirms that he is on the uppermost side of the earth, and wonders how another at *L* can stand on the undermost side with his head hanging downwards. But *U*, in the mean time, forgets that in twelve hours time he will be carried half round with the earth, and then be in the very situation that *L* now is, although as far from him as before. And yet, when *U* comes there, he will find no difference as to his manner of standing; only he will see the opposite half of the heavens, and imagine the heavens to have gone half round the earth.

When we see a globe hung up in a room, we cannot help imagining it to have an upper and an under side, and immediately form a like idea of the earth; from whence we conclude, that it is as impossible for people to stand on the under side of the earth, as for pebbles to lie on the under side of a common globe, which instantly fall down from it to the ground; and well they may, because the attraction of the earth, being greater than the attraction of the globe, pulls them away. Just so would be the case with our earth, if it were placed near a globe much bigger than itself, such as Jupiter; for then it would really have an upper and an under side, with respect to that large globe; which, by its attraction, would pull away every thing from the side of the earth next to it; and only those on the top of the opposite or upper side could remain upon it. But there is no larger globe near enough our earth to overcome its central attraction; and therefore it has no such thing as an upper and an under side; for all bodies, on or near its surface, even to the moon, gravitate towards its centre.

The earth's bulk is but a point, as that at *C*, compared to the heavens; and therefore every inhabitant upon it, let him be where he will, as at *n, e, m, s, &c.* sees half of the heavens. The inhabitant *n*, on the north pole of the earth, constantly sees the hemisphere *ENQ*; and having the north pole *N* of the heavens just over his head, his horizon coincides with the celestial equator *ECQ*. Therefore, all the stars in the northern hemisphere *ENQ*, between the equator and north pole, appear to turn round the line *NC*, moving parallel to the horizon. The equatorial stars keep in the horizon,

and all those in the southern hemisphere *ESQ* are invisible. The like phenomena are seen by the observer (*s*) on the south pole, with respect to the hemisphere *ESQ*; and to him the opposite hemisphere is always invisible. Hence, under either pole, only half of the heavens is seen; for those parts which are once visible never set, and those which are once invisible never rise. But the ecliptic *YCX*, or orbit which the sun appears to describe once a year by the earth's annual motion, has the half *YC* constantly above the horizon *ECQ* of the north pole *n*; and the other half *CX* always below it. Therefore, whilst the sun describes the northern half *YC* of the ecliptic, he neither sets to the north pole, nor rises to the south; and whilst he describes the southern half *CX*, he neither sets to the south pole nor rises to the north. The same things are true with respect to the moon; only with this difference, that as the sun describes the ecliptic but once a year, he is for half that time visible to each pole in its turn, and as long invisible; but as the moon goes round the ecliptic in 27 days 8 hours, she is only visible for 13 days 16 hours, and as long invisible to each pole by turns. All the planets likewise rise and set to the poles, because their orbits are cut obliquely in halves by the horizon of the poles. When the sun (in his apparent way from *X*) arrives at *C*, which is on the 20th of March, he is just rising to an observer *n* on the north pole, and setting to another at *s* on the south pole. From *C* he rises higher and higher in every apparent diurnal revolution, till he comes to the highest point of the ecliptic *y*, on the 21st of June, and then he is at his greatest altitude, which is  $23\frac{1}{2}$  degrees, or the arc *Ey*, equal to his greatest north declination; and from thence he seems to descend gradually in every apparent circumvolution, till he sets at *C* on the 23d of September; and then he goes to exhibit the like appearances at the south pole for the other half of the year. Hence, the sun's apparent motion round the earth is not in parallel circles, but in spirals; such as might be represented by a thread wound round a globe from tropic to tropic; the spirals being at some distance from one another about the equator, and gradually nearer to each other as they approach toward the tropics.

If the observer be any where on the terrestrial equator *eCq*, as suppose at *e*, he is in the plane of the celestial equator; or under the equinoctial *ECQ*; and the axis of the earth *nCs* is coincident with the plane of his horizon, extended out to *N* and *S*, the north and south poles of the heavens. As the earth turns round the line *NCs*, the whole heavens *MOLI* seem to turn round the same line, but the contrary way. It is plain that this observer has the celestial poles constantly in his horizon; and that his horizon cuts the diurnal paths of all the celestial bodies perpendicularly and in halves. Therefore the sun, planets and stars, rise every day, and ascend perpendicularly above the horizon for six hours; and, passing over the meridian, descend in the same manner for the six following hours; then set in the horizon, and continue twelve hours below it. Consequently at the equator the days and nights are equally long throughout the year. When the observer is in the situation *e*, he sees the hemisphere *SEN*; but in twelve hours after,

he is carried half round the earth's axis to  $q$ , and then the hemisphere  $SQN$  becomes visible to him; and  $SEN$  disappears. Thus we find, that to an observer at either of the poles, one half of the sky is always visible, and the other half never seen; but to an observer on the equator, the whole sky is seen every 24 hours.

The figure here referred to, represents a celestial globe of glass, having a terrestrial globe within it; after the manner of the glass-sphere invented by Dr Long, Lowndes's professor of astronomy in Cambridge.

If a globe be held sidewise to the eye, at some distance, and so that neither of its poles can be seen, the equator  $ECQ$ , and all circles parallel to it, as  $DL$ ,  $yzx$ ,  $abX$ ,  $MO$ , &c. will appear to be straight lines, as projected in this figure; which is requisite to be mentioned here, because we shall have occasion to call them circles in the following articles of this chapter.

Let us now suppose that the observer has gone from the equator  $e$  towards the north pole  $n$ , and that he stops at  $i$ , from which place he then sees the hemisphere  $MEINL$ ; his horizon  $MCL$  having shifted as many degrees from the celestial poles  $N$  and  $S$ , as he has travelled from under the equinoctial  $E$ . And as the heavens seem constantly to turn round the line  $NCS$  as an axis, all those stars which are not so many degrees from the north pole  $N$  as the observer is from the equinoctial, namely, the stars north of the dotted parallel  $DL$ , never set below the horizon; and those which are south of the dotted parallel  $MO$  never rise above it. Hence the former of these two parallel circles is called the *circle of perpetual apparition*, and the latter the *circle of perpetual occultation*; but all the stars between these two circles rise and set every day. Let us imagine many circles to be drawn between these two, and parallel to them; those which are on the north side of the equinoctial will be unequally cut by the horizon  $MCL$ , having larger portions above the horizon than below it; and the more so, as they are nearer to the circle of perpetual apparition; but the reverse happens to those on the south side of the equinoctial, whilst the equinoctial is divided in two equal parts by the horizon. Hence, by the apparent turning of the heavens, the northern stars describe greater arcs or portions of circles above the horizon than below it; and the greater, as they are farther from the equinoctial towards the circle of perpetual apparition; whilst the contrary happens to all stars south of the equinoctial; but those upon it describe equal arcs both above and below the horizon, and therefore they are just as long above as below it.

An observer on the equator has no circle of perpetual apparition or occultation, because all the stars, together with the sun and moon, rise and set to him every day. But, as a bare view of the figure is sufficient to shew that these two circles  $DL$  and  $MO$  are just as far from the poles  $N$  and  $S$  as the observer at  $i$  (or one opposite to him at  $o$ ) is from the equator  $ECQ$ , it is plain, that if an observer begins to travel from the equator towards either pole, his circle of perpetual apparition rises from that pole as from a point, and his circle of perpetual occultation from the other. As the observer advances toward the nearer pole, these two circles enlarge their dia-

eters, and come nearer one another, until he comes to the pole; and then they meet and coincide in the equinoctial. On different sides of the equator, to observers at equal distances from it, the circle of perpetual apparition to one is the circle of perpetual occultation to the other.

Because the stars never vary their distances from the equinoctial, so as to be sensible in an age, the lengths of their diurnal and nocturnal arcs are always the same to the same places on the earth. But as the earth goes round the sun every year in the ecliptic, one half of which is on the north side of the equinoctial, and the other half on its south side, the sun appears to change his place every day, so as to go once round the circle  $YCX$  every year. Therefore whilst the sun appears to advance northward, from having described the parallel  $abX$  touching the ecliptic in  $X$ , the days continually lengthen and the nights shorten, until he comes to  $y$  and describes the parallel  $yzx$ , when the days are at the longest and the nights at the shortest; for then, as the sun goes no farther northward, the greatest portion that is possible of the diurnal arc  $yz$  is above the horizon of the inhabitant  $i$ , and the smallest portion  $zx$  below it. As the sun declines southward from  $y$ , he describes smaller diurnal and greater nocturnal arcs, or portions of circles every day; which causeth the days to shorten and nights to lengthen, until he arrives again at the parallel  $abX$ ; which having only the small part  $ab$  above the horizon  $MCL$ , and the great part  $bX$  below it, the days are at the shortest and the nights at the longest; because the sun recedes no farther south, but returns northward as before. It is easy to see that the sun must be in the equinoctial  $ECQ$  twice every year, and then the days and nights are equally long; that is, 12 hours each. These hints serve at present to give an idea of some of the appearances resulting from the motions of the earth; which will be more particularly described in the tenth chapter.

To an observer at either pole, the horizon and equinoctial are coincident; and the sun and stars seem to move parallel to the horizon; therefore, such an observer is said to have a parallel position of the sphere. To an observer any where between either pole and equator, the parallels described by the sun and stars are cut obliquely by the horizon, and therefore he is said to have an oblique position of the sphere. To an observer any where on the equator, the parallels of motion, described by the sun and stars, are cut perpendicularly, or at right angles, by the horizon; and therefore he is said to have a right position of the sphere. And these three are all the different ways that the sphere can be posited to all people on the earth.

CHAP. V. *The Phenomena of the Heavens as seen from different parts of the Solar System.*

So vastly great is the distance of the starry heavens, that if viewed from any part of the solar system, or even many

many millions of miles beyond it, its appearance would be the very same to us. The sun and stars would all seem to be fixed on one concave surface, of which the spectator's eye would be the centre. But the planets being much nearer than the stars, their appearances will vary considerably with the place from which they are viewed.

If the spectator is at rest without their orbits, the planets will seem to be at the same distance as the stars, but continually changing their places with respect to the stars and to one another, assuming various phases of increase and decrease like the moon; and, notwithstanding their regular motions about the sun, will sometimes appear to move quicker, sometimes slower, be as often to the west as to the east of the sun, and at their greatest distances seem quite stationary. The duration, extent, and distance of those points in the heavens where these digressions begin and end, would be more or less, according to the respective distances of the several planets from the sun; but in the same planet they would continue invariably the same at all times; like pendulums of unequal lengths oscillating together, the shorter move quick and go over a small place, the longer move slow and go over a large space. If the observer is at rest within the orbits of the planets, but not near the common centre, their apparent motions will be irregular, but less so than in the former case. Each of the several planets will appear larger and less by turns, as they approach nearer or recede farther from the observer, the nearest varying most in their size. They will also move quicker or slower with regard to their fixed stars, but will never be retrograde or stationary.

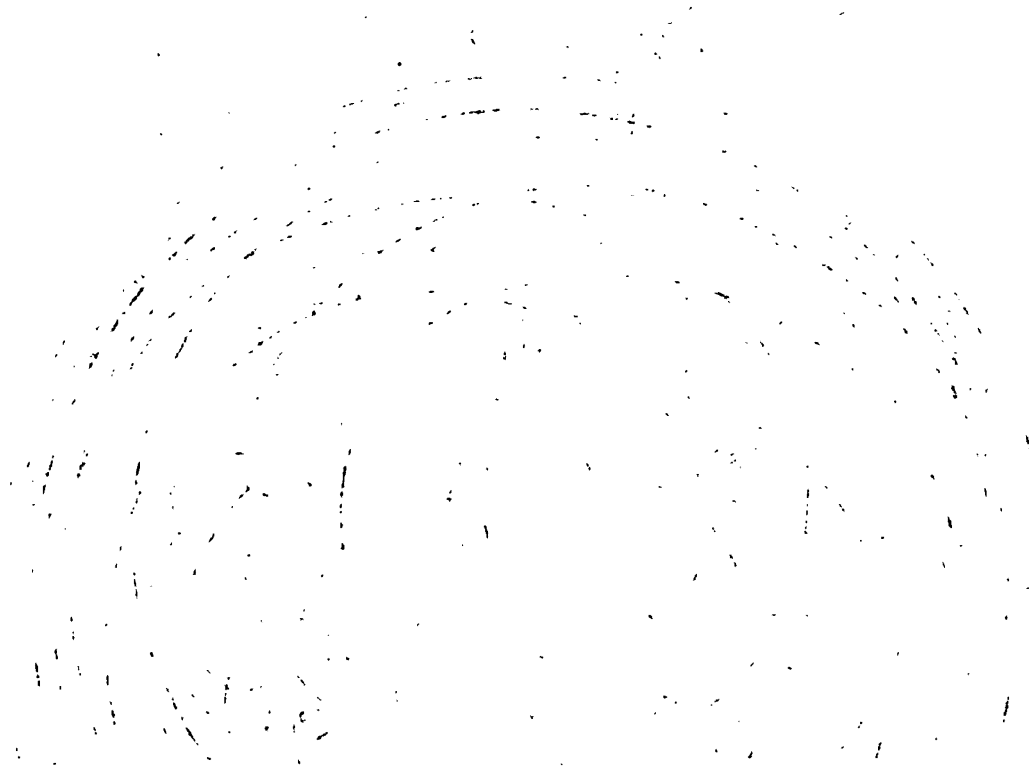
If an observer in motion views the heavens, the same apparent irregularities will be observed, but with some variation resulting from its own motion. If he is on a planet which has a rotation on its axis, not being sensible of his own motion, he will imagine the whole heavens, sun, planets, and stars, to revolve about him in the same time that his planet turns round, but the contrary way, and will not be easily convinced of the deception. If his planet moves round the sun, the same irregularities and aspects as above mentioned will appear in the motions of the other planets; and the sun will seem to move among the fixed stars or signs, directly opposite to those in which his planet moves, changing its place every day as he does. In a word, whether our observer be in motion or at rest, whether within or without the orbits of the planets, their motions will seem irregular, intricate, and perplexed, unless he is in the centre of the system; and from thence the most beautiful order and harmony will be seen by him.

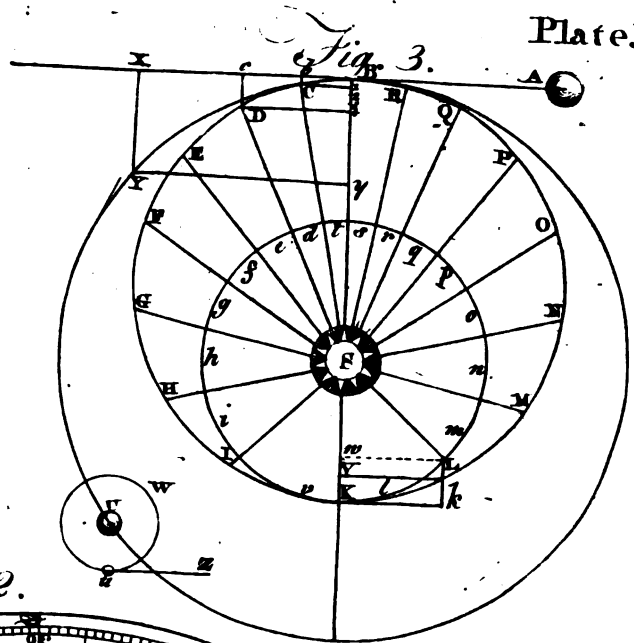
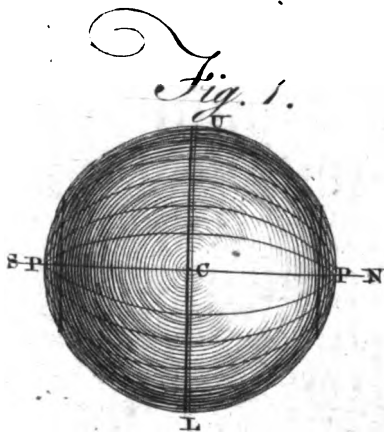
The sun being the centre of all the planets motions, the only place from which their motions could be truly seen is the sun's centre; where the observer, being supposed not to turn round with the sun, (which, in this case, we must imagine to be a transparent body), would see all the stars at rest, and seemingly equidistant from him. To such an observer, the planets would appear to move among the fixed stars, in a simple, regular, and uniform manner; only, that as in equal times they describe equal areas, they would describe spaces somewhat

unequal, because they move in elliptic orbits. Their motions would also appear to be what they are in fact, the same way round the heavens, in paths which cross at small angles in different parts of the heavens, and then separate a little from one another: so that if the solar astronomer should make the path or orbit of any one planet a standard, and consider it as having no obliquity, he would judge the paths of all the rest to be inclined to it, each planet having one half of its path on one side, and the other half on the opposite side of the standard path or orbit. And if he should ever see all the planets start from a conjunction with each other, Mercury would move so much faster than Venus, as to overtake her again (though not in the same point of the heavens) in a quantity of time almost equal to 145 of our days and nights, or, as we commonly call them, *natural days*, which include both the days and nights; Venus would move so much faster than the earth, as to overtake it again in 585 natural days; the earth so much faster than Mars, as to overtake him again in 778 such days; Mars so much faster than Jupiter, as to overtake him again in 817 such days; and Jupiter so much faster than Saturn, as to overtake him again in 7236 days, all of our time.

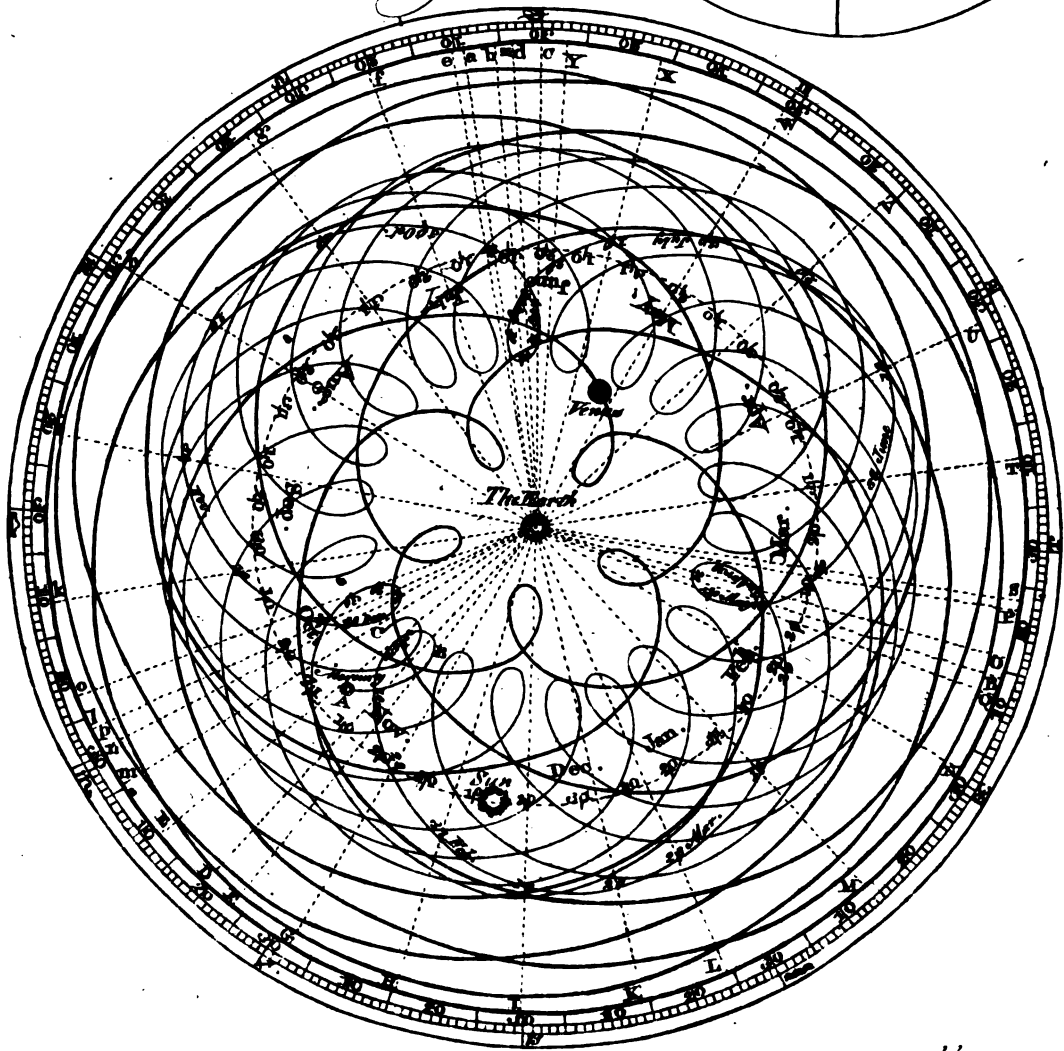
But as our solar astronomer could have no idea of measuring the courses of the planets by our days, he would probably take the period of Mercury, which is the quickest moving planet, for a measure to compare the periods of the others by. As all the stars would appear quiescent to him, he would never think that they had any dependence upon the sun; but would naturally imagine that the planets have, because they move round the sun. And it is by no means improbable, that he would conclude those planets whose periods are quickest, to move in orbits proportionably less than those do which make slower circuits. But being destitute of a method for finding their parallaxes, or, more properly speaking, as they could have no parallax to him, he could never know any thing of their real distances or magnitudes. Their relative distances he might perhaps guess at by their periods, and from thence infer something of truth concerning their relative bulks, by comparing their apparent bulks with one another. For example, Jupiter appearing bigger to him than Mars, he would conclude it to be much bigger in fact; because it appears so, and must be farther from him on account of its longer period. Mercury and the earth would seem much of the same bulk; but, by comparing its period with the earth's, he would conclude that the earth is much farther from him than Mercury, and consequently that it must be really larger, though apparently of the same bulk; and so of the rest. And as each planet would appear somewhat larger in one part of its orbit than in the opposite, and to move quickest when it seems biggest, the observer would be at no loss to determine that all the planets move in orbits, of which the sun is not precisely in the centre.

The apparent magnitudes of the planets continually change as seen from the earth; which demonstrates that they approach nearer to it, and recede farther from it by turns. From these phenomena, and their apparent motions among the stars, they seem to describe looped curves which never return into themselves, Venus's path excepted.





*Fig. 2.*





excepted. And if we were to trace out all their apparent paths, and put the figures of them together in one diagram, they would appear so anomalous and confused, that no man in his senses could believe them to be representations of their real paths; but would immediately conclude, that such apparent irregularities must be owing to some optic illusions: And after a good deal of inquiry, he might perhaps be at a loss to find out the true cause of these inequalities; especially if he were one of those who would rather, with the greatest justice, charge frail man with ignorance, than the Almighty with being the author of such confusion.

Dr Long, in his first volume of Astronomy, has given us figures of the apparent paths of all the planets separately from Cassini; from them Mr Ferguson first thought of attempting to trace some of them by an orrery, that shews the motions of the sun, Mercury, Venus, the earth, and moon, according to the Copernican system. Having taken off the sun, Mercury, and Venus, he put black lead pencils in their places, with the points turned upward, and fixed a circular sheet of pasteboard so that the earth kept constantly under its centre in going round the sun, and the pasteboard kept its parallelism. Then, pressing gently with one hand upon the pasteboard to make it touch the three pencils, with the other hand he turned the winch that moves the whole machinery: and as the earth together with the pencils in the places of Mercury and Venus had their proper motions round the sun's pencils, which kept at rest in the centre of the machine, all the three pencils described a diagram, from which fig. 2. of Plate XL. is truly copied in a smaller size. As the earth moved round the sun, the sun's pencil described the dotted circle of months, whilst Mercury's pencil drew the curve with the greatest number of loops, and Venus's that with the fewest. In their inferior conjunctions they come as much nearer the earth, or within the circle of the sun's apparent motion round the heavens, as they go beyond it in their superior conjunctions. On each side of the loops they appear stationary; in that part of each loop next the earth retrograde; and in all the rest of their paths direct.

If Cassini's figures of the paths of the sun, Mercury, and Venus, were put together, the figure as above traced out would be exactly like them. It represents the sun's apparent motion round the ecliptic, which is the same every year; Mercury's motion for seven years, and Venus's for eight; in which time Mercury's path makes 23 loops, crossing itself so many times, and Venus's only five. In eight years, Venus falls to nearly into the same apparent path again, as to deviate very little from it in some ages; but in what number of years Mercury and the rest of the planets would describe the same visible paths over again, it is hard to determine. Having finished the above figure of the paths of Mercury and Venus, he put the ecliptic round them as in the Doctor's book, and added the dotted lines from the earth to the ecliptic for shewing Mercury's apparent or geocentric motion therein for one year; in which time his path makes three loops, and goes on a little farther; which shews that he has three inferior, and as many superior conjunctions with the sun in that time; and also that he

is six times stationary, and thrice retrograde. Let us now trace his motion for one year in the figure.

In Plate XL. fig. 2. suppose Mercury to be setting out from *A* towards *B*, (between the earth and left-hand corner of the Plate), and as seen from the earth, his motion will then be direct, or according to the order of the signs. But when he comes to *B*, he appears to stand still in the 23d degree of  $\Upsilon$  at *F*, as shewn by the line *BF*. Whilst he goes from *B* to *C*, the line *BF*, supposed to move with him, goes backward from *F* to *E*, or contrary to the order of signs; and when he is at *C*, he appears stationary at *E*, having gone back  $11\frac{1}{2}$  degrees. Now, suppose him stationary on the first of January at *C*, on the 10th thereof he will appear in the heavens as at 20, near *F*; on the 20th, he will be seen as at *G*; on the 31st, at *H*; on the 10th of February, at *I*; on the 20th, at *K*; and on the 28th, at *L*; as the dotted lines shew, which are drawn through every tenth day's motion in his looped path, and continued to the ecliptic. On the 10th of March, he appears at *M*; on the 20th, at *N*; and on the 31st, at *O*. On the 10th of April, he appears stationary at *P*; on the 20th, he seems to have gone back again to *O*; and on the 30th, he appears stationary at *Q*, having gone back  $11\frac{1}{2}$  degrees. Thus Mercury seems to go forward 4 signs 11 degrees, or 131 degrees, and to go back only 11 or 12 degrees, at a mean rate. From the 30th of April to the 10th of May, he seems to move from *Q* to *R*; and on the 20th, he is seen at *S*, going forward in the same manner again, according to the order of letters; and backward when they go back; which it is needless to explain any farther, as the reader can trace him out so easily through the rest of the year. The same appearances happen in Venus's motion; but as she moves slower than Mercury, there are longer intervals of time between them.

CHAP. V. *The physical Causes of the Motions of the Planets. The Excentricities of their Orbits. The Times in which the Action of Gravity alone would bring them to the Sun.*

FROM the uniform projectile motion of bodies in straight lines, and the universal power of attraction which draws them off from these lines, the curvilinear motions of all the planets arise. In Plate XL. fig. 3. if the body *A* be projected along the right line *ABX*, in open space, where it meets with no resistance, and is not drawn aside by any other power, it will for ever go on with the same velocity, and in the same direction. For the force which moves it from *A* to *B* in any given time, will carry it from *B* to *X* in as much more time, and so on, there being nothing to obstruct or alter its motion. But if when this projectile force has carried it, suppose to *B*, the body *S* begins to attract it, with a power duly adjusted, and perpendicular to its motion at *B*, it will then be drawn from the straight line *ABX*, and forced to revolve about *S* in the circle *BYTU*. When the body *A* comes to *U*, or any other part of its orbit, if the small body *u*, within the sphere

of  $U$ 's attraction, be projected as in the right line  $Z$ , with a force perpendicular to the attraction of  $U$ , then  $u$  will go round  $U$  in the orbit  $W$ , and accompany it in its whole course round the body  $S$ . Here  $S$  may represent the sun,  $U$  the earth, and  $u$  the moon.

If a planet at  $B$  gravitates, or is attracted toward the sun so as to fall from  $B$  to  $y$  in the time that the projectile force would have carried it from  $B$  to  $X$ , it will describe the curve  $BT$  by the combined action of these two forces, in the same time that the projectile force singly would have carried it from  $B$  to  $X$ , or the gravitating power singly have caused it to descend from  $B$  to  $y$ ; and these two forces being duly proportioned, and perpendicular to one another, the planet obeying them both, will move in the circle  $BTU$ .

But if, whilst the projectile force carries the planet from  $B$  to  $b$ , the sun's attraction (which constitutes the planet's gravitation) should bring it down from  $B$  to  $1$ , the gravitating power would then be too strong for the projectile force, and would cause the planet to describe the curve  $BC$ . When the planet comes to  $C$ , the gravitating power (which always increases as the square of the distance from the sun  $S$  diminishes) will be yet stronger for the projectile force; and by conspiring in some degree therewith, will accelerate the planet's motion all the way from  $C$  to  $K$ , causing it to describe the arcs,  $BC$ ,  $CD$ ,  $DE$ ,  $EF$ , &c. all in equal times. Having its motion thus accelerated, it thereby gains so much centrifugal force, or tendency to fly off at  $K$  in the line  $Kk$ , as overcomes the sun's attraction; and the centrifugal force being too great to allow the planet to be brought nearer the sun, or even to move round him in the circle  $Klmn$ , &c. it goes off, and ascends in the curve  $KLMN$ , &c. its motion decreasing as gradually from  $K$  to  $B$ , as it increased from  $B$  to  $K$ , because the sun's attraction acts now against the planet's projectile motion just as much as it acted with it before. When the planet has got round to  $B$ ; its projectile force is as much diminished from its mean state about  $G$  or  $N$ , as it was augmented at  $K$ ; and so, the sun's attraction being more than sufficient to keep the planet from going off at  $B$ , it describes the same orbit over again, by virtue of the same forces or powers.

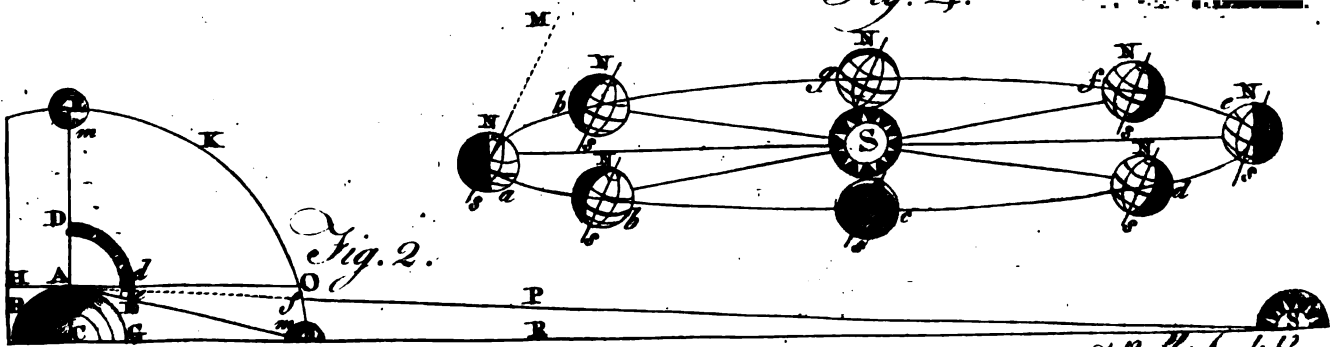
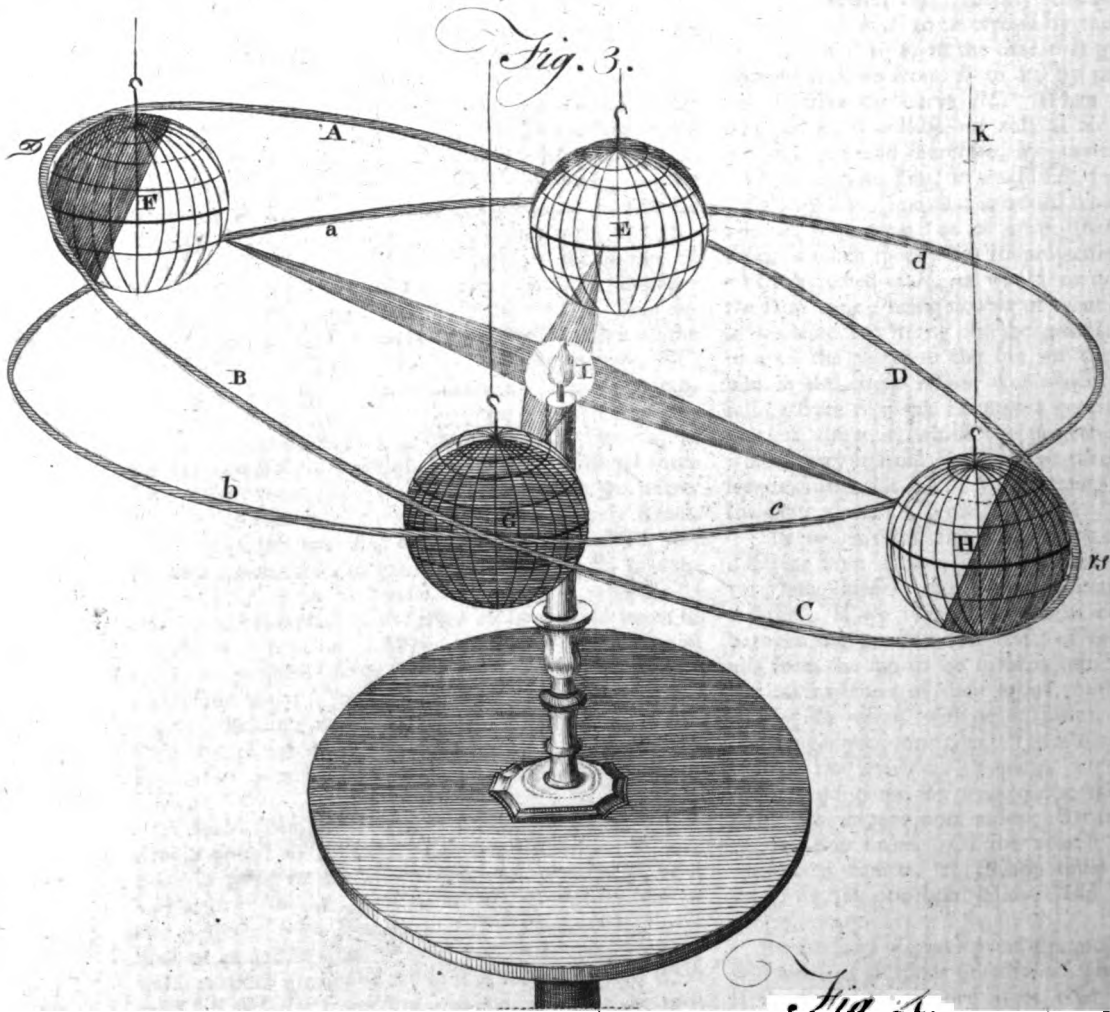
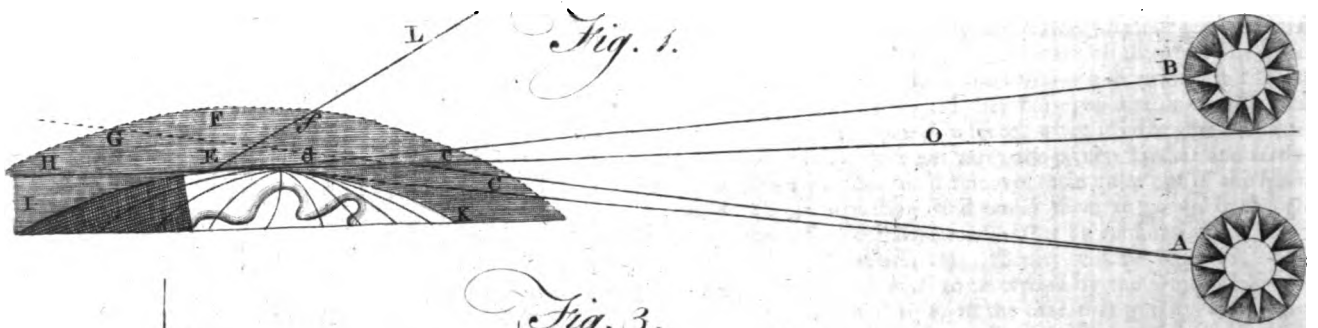
A double projectile force will always balance a quadruple power of gravity. Let the planet at  $B$  have twice as great an impulse from thence towards  $X$ , as it had before; that is, in the same length of time that it was projected from  $B$  to  $b$ , as in the last example, let it now be projected from  $B$  to  $c$ , and it will require four times as much gravity to retain it in its orbit; that is, it must fall as far as from  $B$  to  $4$  in the time that the projectile force would carry it from  $B$  to  $c$ , otherwise it could not describe the curve  $BD$ , as is evident by the figure. But in as much time as the planet moves from  $B$  to  $C$  in the higher part of its orbit, it moves from  $I$  to  $K$ , or from  $K$  to  $L$ , in the lower part thereof; because, from the joint action of these two forces, it must always describe equal areas in equal times, throughout its annual course. These areas are represented by the triangles  $BSC$ ,  $CSD$ ,  $DSE$ ,  $ESF$ , &c. whose contents are equal to one another, quite round the figure.

As the planets approach nearer the sun, and recede farther from him in every revolution, there may be some difficulty in conceiving the reason why the power of gravity, when it once gets the better of the projectile force, does not bring the planets nearer and nearer the sun in every revolution, till they fall upon and unite with him; or why the projectile force, when it once gets the better of gravity, does not carry the planets farther and farther from the sun, till it removes them quite out of the sphere of his attraction, and causes them to go on in straight lines for ever afterward. But by considering the effects of these powers, this difficulty will be removed. Suppose a planet at  $B$  to be carried by the projectile force as far as from  $B$  to  $b$ , in the time that gravity would have brought it down from  $B$  to  $1$ ; by these two forces it will describe the curve  $BC$ . When the planet comes down to  $K$ , it will be but half as far from the sun  $S$  as it was at  $B$ ; and therefore, by gravitating four times as strongly towards him, it would fall from  $K$  to  $V$  in the same length of time that it would have fallen from  $B$  to  $1$  in the higher part of its orbit, that is, through four times as much space; but its projectile force is then so much increased at  $K$ , as would carry it from  $K$  to  $k$  in the same time; being double of what it was at  $B$ , and is therefore too strong for the gravitating power, either to draw the planet to the sun, or cause it to go round him in the circle  $Klmn$ , &c. which would require its falling from  $K$  to  $w$ , through a greater space than gravity can draw it, whilst the projectile force is such as would carry it from  $K$  to  $k$ ; and therefore the planet ascends in its orbit  $KLMN$ , decreasing in its velocity, for the cause already assigned.

The orbits of all the planets are ellipses, very little different from circles; but the orbits of the comets are very long ellipses, and the lower focus of them all is in the sun. If we suppose the mean distance (or middle between the greatest and least) of every planet and comet from the sun to be divided into 1000 equal parts, the excentricities of their orbits, both in such parts and in English miles, will be as follow. Mercury's 210 parts, or 6,720,000 miles; Venus's, 7 parts, or 413,000 miles; the earth's, 17 parts, or 1,377,000 miles; Mars's, 93 parts, or 11,439,000 miles; Jupiter's, 48 parts, or 20,352,000 miles; Saturn's, 55 parts, or 42,735,000 miles. Of the nearest of the three fore-mentioned comets, 1,458,000 miles; of the middlemost, 2,025,000,000 miles; and of the outermost, 6,600,000,000.

By the laws of gravity and the projectile force, bodies will move in all kinds of ellipses, whether long or short, if the spaces they move in be void of resistance; only those which move in the longer ellipses, have so much the less projectile force impressed upon them in the higher parts of their orbits; and their velocities in coming down towards the sun are so prodigiously increased by his attraction, that their centrifugal forces in the lower parts of their orbits are so great, as to overcome the sun's attraction there, and cause them to ascend again towards the higher parts of their orbits; during which time, the sun's attraction acting so contrary to the motions of those bodies, causes them to move slower and slower, until their





their projectile forces are diminished almost to nothing; and then they are brought back again by the sun's attraction, as before.

If the projectile forces of all the planets and comets were destroyed at their mean distances from the sun, their gravities would bring them down so, as that Mercury would fall to the sun in 15 days 13 hours; Venus, in 39 days 17 hours; the earth or moon, in 64 days 10 hours; Mars, in 121 days; Jupiter, in 290; and Saturn, in 767. The nearest comet, in 13 thousand days; the middlemost, in 23 thousand days; and the outermost, in 66 thousand days. The moon would fall to the earth in 4 days 20 hours; Jupiter's first moon would fall to him in 7 hours; his second, in 15; his third, in 30; and his fourth, in 71 hours: Saturn's first moon would fall to him in 8 hours; his second, in 12; his third, in 19; his fourth, in 68; and the fifth, in 336. A stone would fall to the earth's centre, if there were an hollow passage, in 21 minutes 9 seconds. Mr Whiston gives the following rule for such computations. "It is demonstrable, that half the period of any planet, when it is diminished in the sesquialteral proportion of the number 1 to the number 2, or nearly in the proportion of 1000 to 2828, is the time that it would fall to the centre of its orbit." This proportion is, when a quantity or number contains another once and a half as much more.

The quick motions of the moons of Jupiter and Saturn round their primaries, demonstrate that these two planets have stronger attractive powers than the earth has: for the stronger that one body attracts another, the greater must be the projectile force, and consequently the quicker must be the motion of that other body to keep it from falling to its primary or central planet. Jupiter's second moon is 124 thousand miles farther from Jupiter than our moon is from us; and yet this second moon goes almost eight times round Jupiter whilst our moon goes only once round the earth. What a prodigious attractive power must the sun then have, to draw all the planets and satellites of the system towards him; and what an amazing power must it have required to put all these planets and moons into such rapid motions at first!

#### CHAP. VI. *Reasons why the Sun, Moon, and Stars, when rising or setting, appear larger than when they rise higher in the Heavens.*

THE sun and moon appear larger in the horizon than at any considerable height above it. These luminaries, although at great distances from the earth, appear floating, as it were, on the surface of our atmosphere, (Plate XLI. fig. 1.)  $HGFfeC$ , a little way beyond the clouds; of which, those about  $F$ , directly over our heads at  $E$ , are nearer us than those about  $H$  or  $e$  in the horizon  $HEe$ . Therefore, when the sun or moon appear in the horizon at  $e$ , they are not only seen in a part of the sky which is really farther from us than if they were at any considerable altitude, as about  $f$ ; but they are also seen through a greater quantity of air and vapours at  $e$  than at  $f$ . Here

we have two concurring appearances which deceive our imagination, and cause us to refer the sun and moon to a greater distance at their rising or setting about  $e$ , than when they are considerably high, as at  $f$ : first, their seeming to be on a part of the atmosphere at  $e$ , which is really farther than  $f$  from a spectator at  $E$ ; and, secondly, their being seen through a grosser medium when at  $e$  than when at  $f$ , which, by rendering them dimmer, causes us to imagine them to be at a yet greater distance. And as, in both cases, they are seen much under the same angle, we naturally judge them to be largest when they seem farthest from us.

Any one may satisfy himself that the moon appears under no greater angle in the horizon than on the meridian, by taking a large sheet of paper, and rolling it up in the form of a tube, of such a width, that observing the moon through it when she rises, she may, as it were, just fill the tube; then tie a thread round it to keep it of that size; and when the moon comes to the meridian, and appears much less to the eye, look at her again through the same tube, and she will fill it just as much, if not more, than she did at her rising.

When the full moon is in her *perigee*, or at her least distance from the earth, she is seen under a larger angle, and must therefore appear bigger than when she is full at other times: And if that part of the atmosphere where she rises be more replete with vapours than usual, she appears so much the dimmer; and therefore we fancy her to be still the bigger, by referring her to an unusually great distance, knowing that no objects which are very far distant can appear big unless they be really so.

#### CHAP. VII. *Use of the common Quadrant, and the Method of finding the Distances of the Sun, Moon, and Planets.*

To enable the young astronomer to understand the method of finding the distances of the heavenly bodies, we shall here give a short description of the quadrant. This instrument (Plate XLV. fig. 6.) is chiefly used in taking altitudes.

The altitude of any celestial phenomenon is an arc of the sky intercepted between the horizon and the phenomenon. In fig. 6. of Plate XLV. let  $HGX$  be a horizontal line, supposed to be extended from the eye at  $A$  to  $X$ , where the sky and earth seem to meet at the end of a long and level plain; and let  $S$  be the sun. The arc  $XY$  will be the sun's height above the horizon at  $X$ , and is found by the instrument  $EDC$ , which is a quadrantal board, or plate of metal, divided into 90 equal parts or degrees on its limb  $DPC$ ; and has a couple of little brass plates, as  $a$  and  $b$ , with a small hole in each of them, called *sight-holes*, for looking through, parallel to the edge of the quadrant whereon they stand. To the centre  $E$  is fixed one end of a thread  $F$ , called the *plumb-line*, which has a small weight or plummet  $P$  fixed to its other end. Now, if an observer holds the quadrant upright, without inclining it to either side, and so that the horizon at  $X$  is seen through the sight-holes  $a$  and  $b$ , the plumb-line will cut or hang over the beginning of the degrees.

degrees at  $c$ , in the edge  $EC$ ; but if he elevates the quadrant so as to look through the sight-holes at any part of the heavens, suppose to the sun at  $S$ ; just so many degrees as he elevates the sight-hole  $b$  above the horizontal line  $HOX$ , so many degrees will the plumb-line cut in the limb  $CP$  of the quadrant. For, let the observer's eye at  $A$  be in the centre of the celestial arc  $XYV$  (and he may be said to be in the centre of the sun's apparent diurnal orbit, let him be on what part of the earth he will) in which arc the sun is at that time, suppose 25 degrees high; and let the observer hold the quadrant so that he may see the sun through the sight-holes; the plumb-line freely playing on the quadrant will cut the 25th degree in the limb  $CP$ , equal to the number of degrees of the sun's altitude at the time of observation. —[N. B. Whoever looks at the sun, must have a smoked glass before his eyes to save them from hurt. The better way is not to look at the sun through the sight-holes, but to hold the quadrant facing the eye, at a little distance, and so that the sun shining through one hole, the ray may be seen to fall on the other.]

In fig. 2. Plate XLI. let  $BAG$  be one half of the earth,  $AC$  its semidiameter,  $S$  the sun,  $m$  the moon, and  $EKOL$  a quarter of the circle described by the moon in revolving from the meridian to the meridian again. Let  $CRS$  be the rational horizon of an observer at  $A$ , extended to the sun in the heavens; and  $HAO$  his sensible horizon, extended to the moon's orbit.  $ALC$  is the angle under which the earth's semidiameter  $AC$  is seen from the moon at  $L$ , which is equal to the angle  $OAL$ , because the right lines  $AO$  and  $CL$  which include both these angles are parallel.  $ASC$  is the angle under which the earth's semidiameter  $AC$  is seen from the sun at  $S$ , and is equal to the angle  $OAS$ , because the lines  $AO$  and  $CS$  are parallel. Now, it is found by observation, that the angle  $OAL$  is much greater than the angle  $OAS$ ; but  $OAL$  is equal to  $ALC$ , and  $OAS$  is equal to  $ASC$ . Now, as  $ASC$  is much less than  $ALC$ , it proves that the earth's semidiameter  $AC$  appears much greater as seen from the moon at  $L$ , than from the sun at  $S$ ; and therefore the earth is much farther from the sun than from the moon. The quantities of these angles are determined by observation in the following manner.

Let a graduated instrument, as  $DAE$  (the larger the better) having a moveable index with sight-holes, be fixed in such a manner, that its plane surface may be parallel to the plane of the equator, and its edge  $AD$  in the meridian: so that when the moon is in the equinoctial, and on the meridian at  $E$ , she may be seen through the sight-holes when the edge of the moveable index cuts the beginning of the divisions at  $c$ , on the graduated limb  $DE$ ; and when she is so seen, let the precise time be noted. Now, as the moon revolves about the earth, from the meridian to the meridian again, in 24 hours 48 minutes, she will go a fourth part round it in a fourth part of that time, viz. in 6 hours 12 minutes, as seen from  $C$ , that is, from the earth's centre or pole. But as seen from  $A$ , the observer's place on the earth's surface, the moon will seem to have gone a quarter round the earth when she comes to the sensible horizon at  $O$ ; for the index, through the sights of

which she is then viewed, will be at  $d$ , 90 degrees from  $D$ , where it was when she was seen at  $E$ . Now, let the exact moment when the moon is seen at  $O$  (which will be when she is in or near the sensible horizon) be carefully noted, that it may be known in what time she has gone from  $E$  to  $O$ ; which time subtracted from 6 hours 12 minutes (the time of her going from  $E$  to  $L$ ) leaves the time of her going from  $O$  to  $L$ , and affords an easy method for finding the angle  $OAL$  (called the moon's horizontal parallax, which is equal to the angle  $ALC$ ) by the following analogy. As the time of the moon's describing the arc  $EO$  is to 90 degrees, so is 6 hours 12 minutes to the degrees of the arc  $DdE$ , which measures the angle  $EAL$ ; from which subtract 90 degrees, and there remains the angle  $OAL$ , equal to the angle  $ALC$ , under which the earth's semidiameter  $AC$  is seen from the moon. Now, since all the angles of a right-lined triangle are equal to 180 degrees, or to two right angles, and the sides of a triangle are always proportional to the sines of the opposite angles, say, by the Rule of Three, as the sine of the angle  $ALC$  at the moon  $L$  is to its opposite side  $AC$ , the earth's semidiameter, which is known to be 3985 miles, so is the radius, viz. the sine of 90 degrees, or of the right angle  $AGL$ , to its opposite side  $AL$ , which is the moon's distance at  $L$ , from the observer's place at  $A$ , on the earth's surface; or, so is the sine of the angle  $CAL$  to its opposite side  $CL$ , which is the moon's distance from the earth's centre, and comes out, at a mean rate, to be 240,000 miles. The angle  $CAL$  is equal to what  $OAL$  wants of 90 degrees.

The sun's distance from the earth is found the same way, but with much greater difficulty; because his horizontal parallax, or the angle  $OAS$  equal to the angle  $ASC$ , is so small as to be hardly perceptible, being only 10 seconds of a minute, or the 360th part of a degree. But the moon's horizontal parallax, or angle  $OAL$ , equal to the angle  $ALC$ , is very discernible, being  $57' 49''$ , or  $3459''$  at its mean state; which is more than 340 times as great as the sun's: And therefore the distances of the heavenly bodies being inversely as the tangents of their horizontal parallaxes, the sun's distance from the earth is at least 340 times as great as the moon's; and is rather understated at 81 millions of miles, when the moon's distance is certainly known to be 240 thousand. But because, according to some astronomers, the sun's horizontal parallax is 11 seconds, and according to others only 10, the former parallax making the sun's distance to be about 75,000,000 of miles, and the latter 82,000,000; we may take it for granted, that the sun's distance is not less than as deduced from the former, nor more than as shewn by the latter: And every one who is accustomed to make such observations, knows how hard it is, if not impossible, to avoid an error of a second, especially on account of the inconstancy of horizontal refractions: And here, the error of one second, in so small an angle, will make an error of seven millions of miles in so great a distance as that of the sun's.

The sun and moon appear much about the same bulk; and every one who understands geometry, knows how their true bulks may be deduced from the apparent, when their real distances are known. Spheres are to one another

another as the cubes of their diameters; whence, if the sun be 81 millions of miles from the earth, to appear as big as the moon, whose distance does not exceed 240 thousand miles, he must, in solid bulk, be 42 millions 875 thousand times as big as the moon.

The horizontal parallaxes are best observed at the equator. 1. Because the heat is so nearly equal every day, that the refractions are almost constantly the same. 2. Because the parallactic angle is greater there, as at *A* (the distance from thence to the earth's axis being greater) than upon any parallel of latitude, as *a* or *b*.

The earth's distance from the sun being determined, the distances of all the other planets from him are easily

found by the following analogy, their periods round him being ascertained by observation. As the square of the earth's period round the sun is to the cube of its distance from him, so is the square of the period of any other planet to the cube of its distance, in such parts or measures as the earth's distance was taken. This proportion gives us the relative mean distances of the planets from the sun to the greatest degree of exactness; and they are as follow, having been deduced from their periodical times, according to the law just mentioned, which was discovered by Kepler, and demonstrated by Sir Isaac Newton.

*Periodical Revolution to the same fixed Star in Days, and decimal Parts of a Day.*

Of Mercury, 87.9692	Venus, 224.6176	The Earth, 365.2564	Mars, 686.9785	Jupiter, 4332.514	Saturn, 10759.275
<i>Relative mean distances from the sun.</i>					
38710	72333	100000	152369	520096	954006
<i>From these numbers we deduce, that if the sun's horizontal parallax be 10", the real mean distances of the planets from the sun in English miles are,</i>					
31,742,200	59,313,060	82,000,000	124,942,580	426,478,720	782,284,920
<i>But if the sun's parallax be 11", their distances are no more than</i>					
29,032,500	54,238,570	75,000,000	114,276,750	390,034,500	715,504,500
<i>Errors in distance, arising from the mistake of 1" in the sun's parallax.</i>					
2,709,700	5,074,490	7,000,000	10,665,830	36,444,220	66,780,420
<i>But, from the transit of Venus, A. D. 1761, the sun's parallax appears to be only 8" <math>\frac{6}{10}</math>; and according to that, their real distance in miles are</i>					
36,668,373	68,518,044	94,725,840	144,588,575	492,665,307	903,690,197

These numbers shew, that although we have the relative distances of the planets from the sun to the greatest nicety, yet the best observers could not ascertain their true distances, until the above transit appeared, which we must confess was embarrassed with several difficulties. But the late transit of Venus over the sun, on the third of June, was much better suited to this great problem.

The earth's axis produced to the stars, being carried parallel to itself during the earth's annual revolution, describes a circle in the sphere of the fixed stars equal to the orbit of the earth. But this orbit, though very large, would seem no bigger than a point if it were viewed from the stars; and consequently, the circle described in the sphere of the stars, by the axis of the earth produced, if viewed from the earth, must appear but as a point; that is, its diameter appears too little to be measured by observation: For Dr Bradley has assured us, that if it had amounted to a single second, or two at most, he should have perceived it in the great number of observations he has made, especially upon  $\gamma$  *dragonis*; and that it seemed to him very probable that the annual parallax of this star is not so great as a single second; and consequently, that it is above 400 thousand times farther from us than the sun. Hence, the celestial poles seem to continue in the same points of the heavens

throughout the year; which, by no means, disproves the earth's annual motion, but plainly proves the distance of the stars to be exceeding great.

The small apparent motion of the stars, discovered by that great astronomer, he found to be no ways owing to their annual parallax (for it came out contrary thereto) but to the aberration of their light, which can result from no known cause besides that of the earth's annual motion; and as it agrees so exactly therewith, it proves, beyond dispute, that the earth has such a motion: For this aberration completes all its various phenomena every year; and proves that the velocity of star-light is such as carries it through a space equal to the sun's distance from us in 8 minutes 13 seconds of time. Hence, the velocity of light is 10 thousand 210 times as great as the earth's velocity in its orbit; which velocity (from what we know already of the earth's distance from the sun) may be asserted to be at least between 57 and 58 thousand miles every hour: And supposing it to be 58000, this number, multiplied by the above 10210, gives 592 million 180 thousand miles for the hourly motion of light; which last number, divided by 3600, the number of seconds in an hour, shews that light flies at the rate of more than a hundred and sixty-four thousand miles every second of time, or swing of a common clock pendulum.

C H A P. VIII. *The different Lengths of Days and Nights, and the Vicissitudes of Seasons, explained. The Explanation of the Phenomena of Saturn's Ring concluded.*

THE following experiment will give a plain idea of the diurnal and annual motions of the earth, together with the different lengths of days and nights, and all the beautiful variety of seasons, depending on those motions.

Take about seven feet of strong wire, and bend it into a circular form, as *abcd*, which being viewed obliquely, appears elliptical, Plate XLI. fig. 3. Place a lighted candle on a table, and having fixed one end of a silk thread *K*, to the north pole of a small terrestrial globe *H*, about three inches diameter, cause another person to hold the wire circle, so that it may be parallel to the table, and as high as the flame of the candle *L*, which should be in or near the centre. Then, having twisted the thread as towards the left hand, that by untwisting it may turn the globe round eastward, or contrary to the way that the hands of a watch move; hang the globe by the thread within this circle, almost contiguous to it; and as the thread untwists, the globe (which is enlightened half round by the candle as the earth is by the sun) will turn round its axis, and the different places upon it will be carried through the light and dark hemispheres, and have the appearance of a regular succession of days and nights, as our earth has in reality by such a motion. As the globe turns, move your hand slowly, so as to carry the globe round the candle according to the order of the letters *abcd*, keeping its centre even with the wire circle; and you will perceive, that the candle being still perpendicular to the equator, will enlighten the globe from pole to pole in its whole motion round the circle; and that every place on the globe goes equally through the light and the dark, as it turns round by the untwisting of the thread, and therefore has a perpetual equinox. The globe, thus turning round, represents the earth turning round its axis; and the motion of the globe round the candle represents the earth's annual motion round the sun, and shews, that if the earth's orbit had no inclination to its axis, all the days and nights of the year would be equally long, and there would be no different seasons. But now, desire the person who holds the wire, to hold it obliquely in the position *ABCD*, raising the side *S* just as much as he depresses the side *rs*, that the flame may be still in the plane of the circle; and twisting the thread as before, that the globe may turn round its axis the same way as you carry it round the candle, that is, from west to east, let the globe down into the lowermost part of the wire circle at *rs*, and if the circle be properly inclined, the candle will shine perpendicularly on the tropic of Cancer, and the frigid zone, lying within the arctic or north polar circle, will be all in the light, as in the figure; and will keep in the light, let the globe turn round its axis ever so often. From the equator to the north polar circle all the places have longer days and shorter nights; but from the equa-

tor to the south polar circle just the reverse. The sun does not set to any part of the north frigid zone, as shewn by the candle's shining on it, so that the motion of the globe can carry no place of that zone into the dark: And, at the same time, the south frigid zone is involved in darkness, and the turning of the globe brings none of its places into the light. If the earth were to continue in the like part of its orbit, the sun would never set to the inhabitants of the north frigid zone, nor rise to those of the south. At the equator it would be always equal day and night; and as places are gradually more and more distant from the equator, towards the arctic circle, they would have longer days and shorter nights; whilst those on the south side of the equator would have their nights longer than their days. In this case there would be continual summer on the north side of the equator, and continual winter on the south side of it.

But as the globe turns round its axis, move your hand slowly forward, so as to carry the globe from *H* towards *E*, and the boundary of light and darkness will approach towards the north pole, and recede towards the south pole; the northern places will go through less and less of the light, and the southern places through more and more of it; shewing how the northern days decrease in length, and the southern days increase, whilst the globe proceeds from *H* to *E*. When the globe is at *E*, it is at a mean state between the lowest and highest part of its orbit; the candle is directly over the equator, the boundary of light and darkness just reaches to both the poles, and all places on the globe go equally through the light and dark hemispheres, shewing that the days and nights are then equal at all places of the earth, the poles only excepted; for the sun is then setting to the north pole, and rising to the south pole.

Continue moving the globe forward, and as it goes thro' the quarter *A*, the north pole recedes still farther into the dark hemisphere, and the south pole advances more into the light, as the globe comes nearer to *S*: And when it comes there at *F*, the candle is directly over the tropic of Capricorn, the days are at the shortest, and nights at the longest, in the northern hemisphere, all the way from the equator to the arctic circle; and the reverse in the southern hemisphere from the equator to the antarctic circle; within which circles it is dark to the north frigid zone, and light to the south.

Continue both motions, and as the globe moves through the quarter *B*, the north pole advances towards the light, and the south pole recedes towards the dark; the days lengthen in the northern hemisphere, and shorten in the southern; and when the globe comes to *G*, the candle will be again over the equator (as when the globe was at *E*) and the days and nights will again be equal as formerly; and the north pole will be just coming into the light, the south pole going out of it.

Thus we see the reason why the days lengthen and shorten from the equator to the polar circles every year; why there is no day or night for several turnings of the earth, within the polar circles; why there is but one day and one night in the whole year at the poles; and why the days and nights are equally long all the year



year round at the equator, which is always equally cut by the circle bounding light and darkness.

The inclination of an axis or orbit is merely relative, because we compare it with some other axis or orbit which we consider as not inclined at all. Thus, our horizon being level to us whatever place of the earth we are upon, we consider it as having no inclination; and yet, if we travel 90 degrees from that place, we shall then have an horizon perpendicular to the former, but it will still be level to us. And if this book be held so that the circle *ABCD* be parallel to the horizon, both the circle *abcd*, and the thread or axis *K*, will be inclined to it. But if the book or plate be held so that the thread be perpendicular to the horizon, then the orbit *ABCD* will be inclined to the thread, and the orbit *abcd* perpendicular to it, and parallel to the horizon. We generally consider the earth's annual orbit as having no inclination, and the orbits of all the other planets as inclined to it.

Let us now take a view of the earth in its annual course round the sun, considering its orbit as having no inclination, and its axis as inclining  $23\frac{1}{2}$  degrees from a line perpendicular to the plane of its orbit, and keeping the same oblique direction in all parts of its annual course; or, as commonly termed, keeping always parallel to itself.

In Plate XLI. fig. 4. let *abcdefgh* be the earth in eight different parts of its orbit, equidistant from one another, *N* its axis, *N* the north pole, *s* the south pole, and *S* the sun nearly in the centre of the earth's orbit. As the earth goes round the sun according to the order of the letters *abcd*, &c. its axis *Ns* keeps the same obliquity, and is still parallel to the line *MNs*. When the earth is at *a*, its north pole inclines toward the sun *S*, and brings all the northern places more into the light than at any other time of the year. But when the earth is at *e* in the opposite time of the year, the north pole declines from the sun, which occasions the northern places to be more in the dark than in the light; and the reverse at the southern places, as is evident by the figure. When the earth is either at *c* or *g*, its axis inclines not either to or from the sun, but lies sidewise to him, and then the poles are in the boundary of light and darkness; and the sun, being directly over the equator, makes equal day and night at all places. When the earth is at *b*, it is half way between the summer solstice and harvest equinox; when it is at *d*, it is half way from the harvest equinox to the winter solstice; at *f*, half way from the winter solstice to the spring equinox; and at *h*, half way from the spring equinox to the summer solstice.

From this oblique view of the earth's orbit, let us suppose ourselves to be raised far above it, and placed just over its centre *S*, looking down upon it from its north pole; and as the earth's orbit differs but very little from a circle, we shall have its figure in such a view represented by the circle *ABCDEFGH* (Plate XLII. fig. 1.). Let us suppose this circle to be divided into 12 equal parts, called *signs*, having their names affixed to them; and each sign into 30 equal parts, called *degrees*, numbered 10, 20, 30, as in the outermost circle of the fi-

gure, which represents the great ecliptic in the heavens. The earth is shewn in eight different positions in this circle, and in each position *Æ* is the equator, *T* the tropic of Cancer, the *dotted circle* the parallel of London, *U* the arctic or north polar circle, and *P* the north pole, where all the meridians or hour-circles meet. As the earth goes round the sun, the north pole keeps constantly towards one part of the heavens, as it keeps in the figure towards the right-hand side of the plate.

When the earth is at the beginning of *Libra*, namely, on the 20th of March, in this figure (as at *g* in Plate XLI. fig. 4.) the sun *S* as seen from the earth appears at the beginning of *Aries* in the opposite part of the heavens, the north pole is just coming into the light, and the sun is vertical to the equator; which, together with the tropic of Cancer, parallel of London, and arctic circle, are all equally cut by the circle bounding light and darkness, coinciding with the six o'clock hour-circle, and therefore the days and nights are equally long at all places; for every part of the meridian *ÆTLa* comes into the light at six in the morning, and revolving with the earth according to the order of the hour-letters, goes into the dark at six in the evening. There are 24 meridians or hour-circles drawn on the earth in this figure, to shew the time of sun-rising and setting at different seasons of the year.

As the earth moves in the ecliptic according to the order of the letters *ABCD*, &c. through the signs *Libra*, *Scorpio*, and *Sagittarius*, the north pole comes more and more into the light; the days increase as the nights decrease in length, at all places north of the equator *Æ*; which is plain by viewing the earth at *b* on the 5th of *May*, when it is in the 15th degree of *Scorpio*, and the sun as seen from the earth appears in the 15th degree of *Taurus*; for then the tropic of *Cancer T* is in the light from a little after five in the morning till almost seven in the evening; the parallel of London from half an hour past four till half an hour past seven; the polar circle *U* from three till nine; and a large track round the north pole *P* has day all the 24 hours, for many rotations of the earth on its axis.

When the earth comes to *c* at the beginning of *Capricorn*, and the sun as seen from the earth appears at the beginning of *Cancer* on the 21st of *June*, as in this figure, it is in the position *a* in Plate XLI. fig. 4.; and its north pole inclines towards the sun, so as to bring all the north frigid zone into the light, and the northern parallels of latitude more into the light than the dark from the equator to the polar circle, and the more so as they are farther from the equator. The tropic of *Cancer* is in the light from five in the morning till seven at night; the parallel of London from a quarter before four till a quarter after eight; and the polar circle just touches the dark, so that the sun has only the lower half of his disk hid from the inhabitants on that circle for a few minutes about midnight, supposing no inequalities in the horizon, and no refractions.

A bare view of the figure is enough to shew, that as the earth advances from *Capricorn* towards *Aries*, and the sun appears to move from *Cancer* towards *Libra*, the north pole recedes towards the dark, which causes the days to decrease, and the nights to increase in length,

all:

till the earth comes to the beginning of Aries, and then they are equal as before; for the boundary of light and darkness cut the equator and all its parallels equally or in halves. The north pole then goes into the dark, and continues therein until the earth goes half way round its orbit, or from the 23d of September till the 20th of March. In the middle between these times, *viz.* on the 22d of December, the north pole is as far as it can be in the dark, which is  $23\frac{1}{2}$  degrees, equal to the inclination of the earth's axis from a perpendicular to its orbit; and then the northern parallels are as much in the dark as they were in the light on the 21st of June; the winter nights being as long as the summer days, and the winter days as short as the summer nights. It is needless to enlarge farther on this subject, as we shall have occasion to mention the seasons again in describing the orrery. Only this must be noted, that all that has been said of the northern hemisphere, the contrary must be understood of the southern; for on different sides of the equator the seasons are contrary, because when the northern hemisphere inclines towards the sun, the southern declines from him.

As Saturn goes round the sun, his obliquely posited ring, like our earth's axis, keeps parallel to itself, and is therefore turned edgewise to the sun twice in a Saturnian year, which is almost as long as 30 of our years. But the ring, though considerably broad, is too thin to be seen by us when it is turned round edgewise to the sun, at which time it is also edgewise to the earth, and therefore it disappears once in every fifteen years to us. As the sun shines half a year together on the north pole of our earth, then disappears to it, and shines as long on the south pole; so, during one half of Saturn's year, the sun shines on the north side of his ring, then disappears to it, and shines as long on its south side. When the earth's axis inclines neither to nor from the sun, but sidewise to him, he instantly ceases to shine on one pole, and begins to enlighten the other; and when Saturn's ring inclines neither to nor from the sun, but sidewise to him, he ceases to shine on the one side of it, and begins to shine upon the other.

The earth's orbit being elliptical, and the sun constantly keeping in its lower focus, which is 1,377,000 miles from the middle point of the longer axis, the earth comes twice so much, or 2,754,000 miles nearer the sun at one time of the year than at another; for the sun appearing under a larger angle in our winter than summer, proves that the earth is nearer the sun in winter. But here this natural question will arise, Why have we not the hottest weather when the earth is nearest the sun? In answer, it must be observed, that the eccentricity of the earth's orbit, or 1 million 377 miles, bears no greater proportion to the earth's mean distance from the sun than 17 does to 1000; and therefore this small difference of distance cannot occasion any great difference of heat or cold. But the principal cause of this difference is, that in winter the sun's rays fall so obliquely upon us, that any given number of them is spread over a much greater portion of the earth's surface where we live, and therefore each point must then have fewer rays than in summer. Moreover, there comes a greater degree of cold

in the long winter nights than there can return of heat in so short days; and on both these accounts the cold must increase. But in summer, the rays fall more perpendicularly upon us, and therefore come with greater force, and in greater numbers on the same place; and by their long continuance, a much greater degree of heat is imparted by day than can fly off by night.

#### CHAP. IX. *The Method of finding the Longitude by the Eclipses of Jupiter's Satellites: The amazing Velocity of Light demonstrated by these Eclipses.*

GEOGRAPHERS arbitrarily chuse to call the meridian of some remarkable place the *first meridian*. There they begin their reckoning; and just so many degrees and minutes as any other place is to the eastward or westward of that meridian, so much east or west longitude they say it has. A degree is the 360th part of a circle, be it great or small; and a minute the 60th part of a degree. The English geographers reckon the longitude from the meridian of the Royal Observatory at Greenwich, and the French from the meridian of Paris.

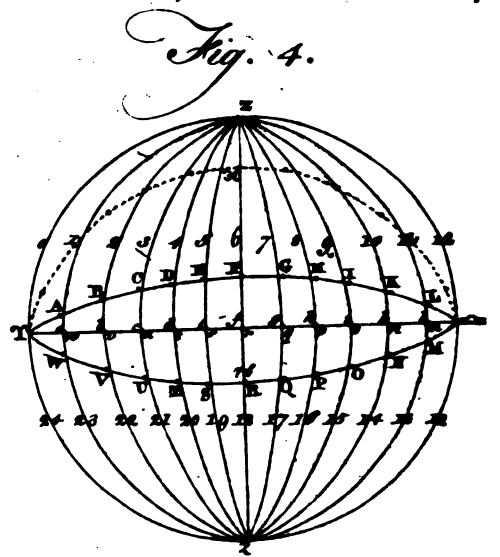
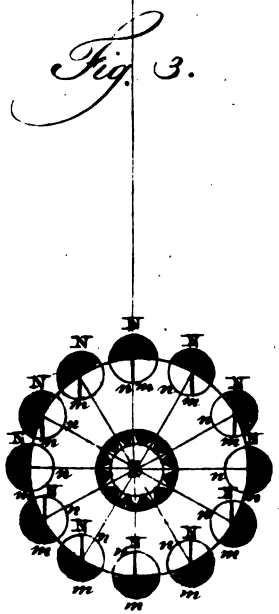
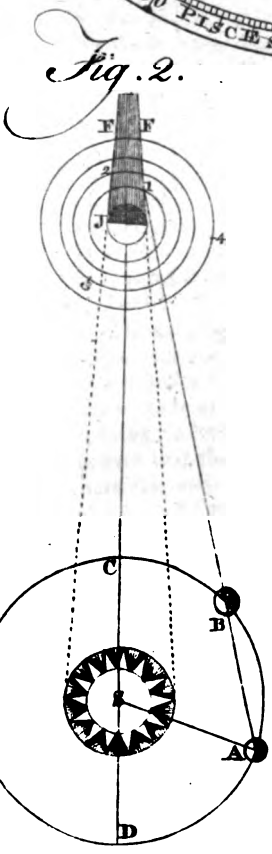
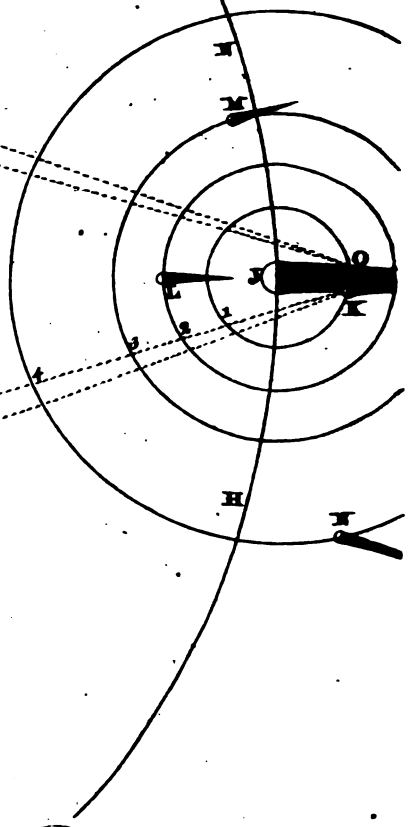
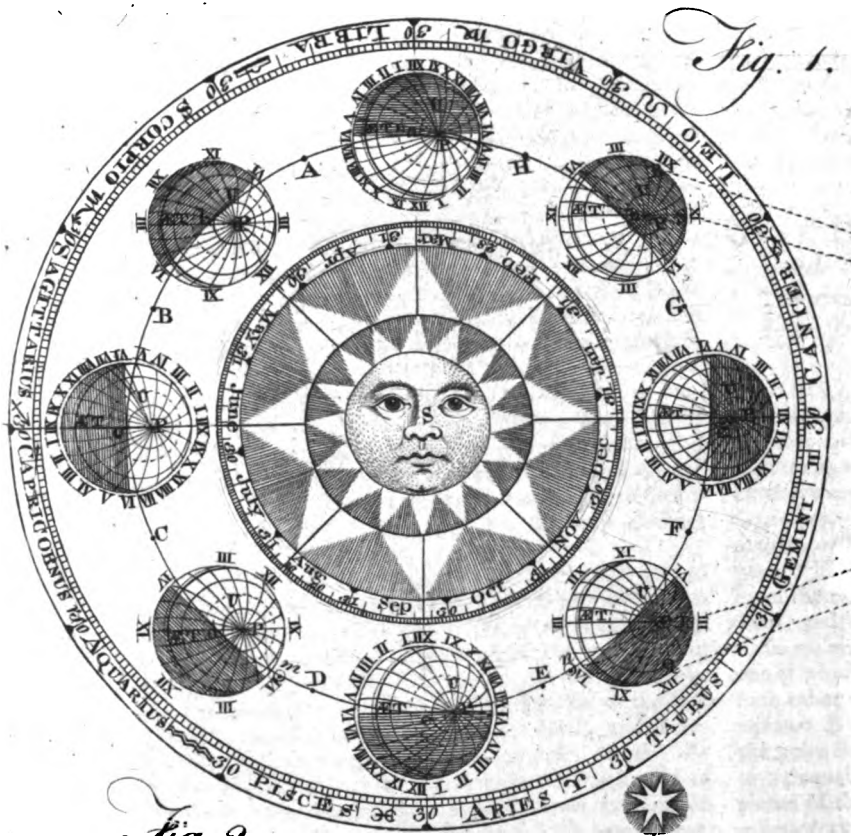
If we imagine 12 great circles, (Plate XLII. fig. 1.) one of which is the meridian of any given place, to intersect each other in the two poles of the earth, and to cut the equator *Æ* at every 15th degree, they will be divided by the poles into 24 semicircles which divide the equator into 24 equal parts; and as the earth turns on its axis, the planes of these semicircles come successively after one another every hour to the sun. As in an hour of time there is a revolution of 15 degrees of the equator, in a minute of time there will be a revolution of 15 minutes of the equator, and in a second of time a revolution of 15 seconds.

Because the sun enlightens only one half of the earth at once, as it turns round its axis, he rises to some places at the same moments of absolute time that he sets to others; and when it is mid-day to some places, it is midnight to others. The XII on the middle of the earth's enlightened side, next the sun, stands for mid-day; and the opposite XII on the middle of the dark side, for midnight. If we suppose this circle of hours to be fixed in the plane of the equinoctial, and the earth to turn round within it, any particular meridian will come to the different hours so as to shew the true time of the day or night at all places on that meridian. Therefore,

To every place 15 degrees eastward from any given meridian, it is noon an hour sooner than on that meridian, because their meridian comes to the sun an hour sooner; and to all places 15 degrees westward, it is noon an hour later, because their meridian comes an hour later to the sun, and so on; every 15 degrees of motion causing an hour's difference in time. Therefore, they who have noon an hour later than we, have their meridian, that is, their longitude, 15 degrees westward from us; and they who have noon an hour sooner than we, have their meridian 15 degrees eastward from ours; and so for every hour's difference of time 15 degrees differ-

ence





rence of longitude. Consequently, if the beginning or ending of a lunar eclipse be observed, suppose at London, to be exactly at midnight, and in some other place at 11 at night, that place is 15 degrees westward from the meridian of London; if the same eclipse be observed at 1 in the morning at another place, that place is 15 degrees eastward from the said meridian.

But as it is not easy to determine the exact moment either of the beginning or ending of a lunar eclipse, because the earth's shadow, through which the moon passes, is faint and ill defined about the edges, we have recourse to the eclipses of Jupiter's satellites, which disappear so instantaneously as they enter Jupiter's shadow, and emerge so suddenly out of it, that we may fix the phenomenon to half a second of time. The first or nearest satellite to Jupiter is the most advantageous for this purpose, because its motion is quicker than the motion of any of the rest, and therefore its immersions and emersions are more frequent.

The English astronomers have calculated tables for shewing the times of the eclipses of Jupiter's satellites to great precision, for the meridian of Greenwich. Now, let an observer, who has these tables, with a good telescope and a well-regulated clock at any other place of the earth, observe the beginning or ending of an eclipse of one of Jupiter's satellites, and note the precise moment of time that he saw the satellite either immerse into, or emerge out of the shadow, and compare that time with the time shewn by the tables for Greenwich; then, 15 degrees difference of longitude being allowed for every hour's difference of time, will give the longitude of that place from Greenwich, as above; and if there be any odd minutes of time, for every minute a quarter of a degree, east or west, must be allowed, as the time of observation is later or earlier than the time shewn by the tables. Such eclipses are very convenient for this purpose at land, because they happen almost every day; but are of no use at sea, because the rolling of the ship hinders all nice telescopical observations.

To explain this by a figure, in Plate XLII. fig. 1. let  $J$  be Jupiter,  $K, L, M, N$  his four satellites in their respective orbits, 1, 2, 3, 4; and let the earth be at  $f$ , (suppose in November, although that month is no otherwise material than to find the earth readily in this scheme, where it is shewn in eight different parts of its orbit). Let  $Q$  be a place on the meridian of Greenwich, and  $R$  a place on some other meridian eastward from Greenwich. Let a person at  $R$  observe the instantaneous vanishing of the first satellite  $K$  into Jupiter's shadow, suppose at three o'clock in the morning; but by the tables he finds the immersion of that satellite to be at midnight at Greenwich; he can then immediately determine, that as there are three hours difference of time between  $Q$  and  $R$ , and that  $R$  is three hours forwarder in reckoning than  $Q$ , it must be 45 degrees of east longitude from the meridian of  $Q$ . Were this method as practicable at sea as at land, any sailor might almost as easily, and with equal certainty, find the longitude as the latitude.

Whilst the earth is going from  $C$  to  $F$  in its orbit, only the immersions of Jupiter's satellites into his shadow are generally seen; and their emersions out of

it while the earth goes from  $G$  to  $B$ . Indeed, both these appearances may be seen of the second, third, and fourth satellite when eclipsed, whilst the earth is between  $D$  and  $E$ , or between  $G$  and  $A$ ; but never of the first satellite, on account of the smallness of its orbit and the bulk of Jupiter, except only when Jupiter is directly opposite to the sun, that is, when the earth is at  $g$ ; and even then, strictly speaking, we cannot see either the immersions or emersions of any of his satellites, because his body, being directly between us and his conical shadow, his satellites are hid by his body a few moments before they touch his shadow; and are quite emerged from thence before we can see them, as it were, just dropping from him. And when the earth is at  $c$ , the sun, being between it and Jupiter, hides both him and his moons from us.

In this diagram, the orbits of Jupiter's moons are drawn in true proportion to his diameter; but, in proportion to the earth's orbit, they are drawn 81 times too large.

In whatever month of the year Jupiter is in conjunction with the sun, or in opposition to him, in the next year it will be a month later at least. For whilst the earth goes once round the sun, Jupiter describes a twelfth part of his orbit. And therefore, when the earth has finished its annual period, from being in a line with the sun and Jupiter, it must go as much forwarder as Jupiter has moved in that time, to overtake him again; just like the minute-hand of a watch, which must, from any conjunction with the hour-hand, go once round the dial-plate and somewhat above a twelfth part more, to overtake the hour-hand again.

It is found by observation, that when the earth is between the sun and Jupiter, as at  $g$ , his satellites are eclipsed about 8 minutes sooner than they should be according to the tables; and when the earth is at  $B$  or  $C$ , these eclipses happen about 8 minutes later than the tables predict them. Hence it is undeniably certain, that the motion of light is not instantaneous, since it takes about  $16\frac{1}{2}$  minutes of time to go through a space equal to the diameter of the earth's orbit, which is 162 millions of miles in length; and consequently the particles of light fly about 164 thousand 494 miles every second of time, which is above a million of times swifter than the motion of a cannon-bullet. And as light is  $8\frac{1}{2}$  minutes in travelling across the earth's orbit, it must be  $8\frac{1}{2}$  minutes in coming from the sun to us; therefore if the sun were annihilated, we should see him for  $8\frac{1}{2}$  minutes after; and if he were again created, he would be  $8\frac{1}{2}$  minutes old before we could see him.

To illustrate this progressive motion of light, (Plate XLII. fig. 2.), let  $A$  and  $B$  be the earth in two different parts of its orbit, whose distance from each other is 81 millions of miles, equal to the earth's distance from the sun  $S$ . It is plain, that if the motion of light were instantaneous, the satellite 1 would appear to enter into Jupiter's shadow  $FF$  at the same moment of time to a spectator in  $A$ , as to another in  $B$ . But by many years observations it has been found, that the immersion of the satellite into the shadow is seen  $8\frac{1}{2}$  minutes sooner when the earth is at  $B$ ; than when it is at  $A$ . And so, as

Mr Romear first discovered, the motion of light is thereby proved to be progressive, and not instantaneous, as was formerly believed. It is easy to compute in what time the earth moves from  $A$  to  $B$ ; for the chord of 60 degrees of any circle is equal to the semidiameter of that circle; and as the earth goes through all the 360 degrees of its orbit in a year, it goes through 60 of those degrees in about 61 days. Therefore, if on any given day, suppose the first of June, the earth is at  $A$ , on the first of August it will be at  $B$ ; the chord, or straight line  $AB$ , being equal to  $DS$  the radius of the earth's orbit, the same with  $AS$  its distance from the sun.

As the earth moves from  $D$  to  $C$ , through the side  $DB$  of its orbit, it is constantly meeting the light of Jupiter's satellites sooner, which occasions an apparent acceleration of their eclipses; and as it moves through the other half  $H$  of its orbit, from  $C$  to  $D$ , it is receding from their light, which occasions an apparent retardation of their eclipses, because their light is then longer before it overtakes the earth.

That these accelerations of the immersions of Jupiter's satellites into his shadow, as the earth approaches towards Jupiter, and the retardations of their emersions out of his shadow, as the earth is going from him, are not occasioned by any inequality arising from the motions of the satellites in excentric orbits, is plain, because it affects them all alike, in whatever parts of their orbits they are eclipsed. Besides, they go often round their orbits every year, and their motions are no way commensurate to the earth's. Therefore, a phenomenon not to be accounted for from the real motions of the satellites, but so easily deducible from the earth's motion, and so answerable thereto, must be allowed to result from it. This affords one very good proof of the earth's annual motion.

### CHAP. X. Of Solar and Sydereal Time.

THE fixed stars appear to go round the earth in 23 hours 56 minutes 4 seconds, and the sun in 24 hours; so that the stars gain three minutes 56 seconds upon the sun every day, which amounts to one diurnal revolution in a year; and therefore, in 365 miles, as measured by the returns of the sun to the meridian, there are 366 days, as measured by the stars returning to it; the former are called *solar days*, and the latter *sydereal*.

The diameter of the earth's orbit is but a physical point in proportion to the distance of the stars; for which reason, and the earth's uniform motion on its axis, any given meridian will revolve from any star to the same star again in every absolute turn of the earth on its axis, without the least perceptible difference of time shewn by a clock which goes exactly true.

If the earth had only a diurnal motion, without an annual, any given meridian would revolve from the sun to the sun again in the same quantity of time as from any star to the same star again, because the sun would never change his place with respect to the stars. But as the earth advances almost a degree eastward in its orbit in the time that it turns eastward round its axis, whatever

star, passes over the meridian on any day with the sun, will pass over the same meridian on the next day when the sun is almost a degree short of it; that is, 3 minutes 56 seconds sooner. If the year contained only 360 days, as the ecliptic does 360 degrees, the sun's apparent place, so far as his motion is equable, would change a degree every day; and then the sydereal days would be just four minutes shorter than the solar.

In Plate XLII, fig. 3, let  $ABCDEFGHIKLM$  be the earth's orbit, in which it goes round the sun every year, according to the order of the letters, that is, from west to east; and turns round its axis the same way from the sun to the sun again every 24 hours. Let  $S$  be the sun, and  $R$  a fixed star, at such an immense distance, that the diameter of the earth's orbit bears no sensible proportion to that distance. Let  $Nn$  be any particular meridian of the earth, and  $N$  a given point or place upon that meridian. When the earth is at  $A$ , the sun  $S$  hides the star  $R$ , which would always be hid if the earth never removed from  $A$ ; and consequently, as the earth turns round its axis, the point  $N$  would always come round to the sun and star at the same time. But when the earth has advanced, suppose a twelfth part of its orbit from  $A$  to  $B$ , its motion round its axis will bring the point  $N$  a twelfth part of a natural day, or two hours, sooner to the star than to the sun; for the angle  $NBn$  is equal to the angle  $ASB$ ; and therefore any star, which comes to the meridian at noon with the sun when the earth is at  $A$ , will come to the meridian at 10 in the forenoon when the earth is at  $B$ . When the earth comes to  $C$ , the point  $N$  will have the star on its meridian at 8 in the morning, or four hours sooner than it comes round to the sun; for it must revolve from  $N$  to  $n$ , before it has the sun in its meridian. When the earth comes to  $D$ , the point  $N$  will have the star on its meridian at 6 in the morning, but that point must revolve six hours more from  $N$  to  $n$ , before it has mid-day by the sun: For now the angle  $ASD$  is a right angle, and so is  $NDn$ ; that is, the earth has advanced 90 degrees in its orbit, and must turn 90 degrees on its axis to carry the point  $N$  from the star to the sun: For the star always comes to the meridian when  $Nm$  is parallel to  $RSA$ ; because  $DS$  is but a point in respect of  $RS$ . When the earth is at  $E$ , the star comes to the meridian at 4 in the morning; at  $F$ , at 2 in the morning; and at  $G$ , the earth having gone half round its orbit,  $N$  points to the star  $R$  at midnight, it being then directly opposite to the sun; and therefore, by the earth's diurnal motion, the star comes to the meridian 12 hours before the sun. When the earth is at  $H$ , the star comes to the meridian at 10 in the evening; at  $I$ , it comes to the meridian 8, that is, 16 hours before the sun; at  $K$ , 18 hours before him; at  $L$ , 20 hours; at  $M$ , 22; and at  $A$ , equally with the sun again.

Thus it is plain, that an absolute turn of the earth on its axis (which is always completed when any particular meridian comes to be parallel to its situation at any time of the day before) never brings the same meridian round from the sun to the sun again; but that the earth requires as much more than one turn on its axis to finish a natural day, as it has gone forward in that time; which, at a

mean

mean state, is a 365th part of a circle. Hence, in 365 days the earth turns 366 times round its axis; and therefore, as a turn of the earth on its axis completes a syderal day, there must be one syderal day more in a year than the number of solar days, be the number what it will, on the earth, or any other planet. One turn being lost with respect to the number of solar days in a year, by the planets going round the sun; just as it would be lost to a traveller, who, in going round the earth, would lose one day by following the apparent diurnal motion of the sun; and consequently would reckon one day less at his return (let him take what time he would to go round the earth) than those who remained all the while at the place from which they set out. So, if there were two earths revolving equably on their axes, and if one remained at *A* until the other travelled round the sun from *A* to *A* again, that earth which kept its place at *A* would have its solar and syderal days always of the same length; and so would have one solar day more than the other at its return. Hence, if the earth turned but once round its axis in a year, and if that turn was made the same way as the earth goes round the sun, there would be continual day on one side of the earth, and continual night on the other.

### CHAP. XI. *Of the Equation of Time.*

THE earth's motion on its axis being perfectly uniform, and equal at all times of the year, the syderal days are always precisely of an equal length; and so would the solar or natural days be, if the earth's orbit were a perfect circle, and its axis perpendicular to its orbit. But the earth's diurnal motion on an inclined axis, and its annual motion in an elliptic orbit, cause the suns apparent motion in the heavens to be unequal: For sometimes he revolves from the meridian to the meridian again in somewhat less than 24 hours, shewn by a well-regulated clock; and at other times in somewhat more: So that the time shewn by an equal going clock and a true sun-dial is never the same but on the 15th of April, the 16th of June, the 31st of August, and the 24th of December. The clock, if it goes equally and true all the year round, will be before the sun from the 24th of December till the 15th of April; from that time till the 16th of June the sun will be before the clock; from the 16th of June till the 31st of August, the clock will be again before the sun; and from thence to the 24th of December the sun will be faster than the clock.

The easiest and most expeditious way of drawing a meridian line is this: Make four or five concentric circles, about a quarter of an inch from one another, on a flat board, about a foot in breadth; and let the outmost circle be but little less than the board will contain. Fix a pin perpendicularly in the centre, and of such a length that its whole shadow may fall within the innermost circle, for at least four hours in the middle of the day. The pin ought to be about an eighth part of an inch thick, and to have a round blunt point. The board being set exactly level in a place where the sun shines,

suppose from eight in the morning till four in the afternoon, about which hours the end of the shadow should fall without all the circles; watch the times in the forenoon, when the extremity of the shortening shadow just touches the several circles, and *there* make marks. Then, in the afternoon of the same day, watch the lengthening shadow, and where its end touches the several circles in going over them, make marks also. Lastly, with a pair of compasses, find exactly the middle point between the two marks on any circle, and draw a straight line from the centre to that point; which line will be covered at noon by the shadow of a small upright wire, which should be put in the place of the pin. The reason for drawing several circles is, that in case one part of the day should prove clear, and the other part somewhat cloudy, if you miss the time when the point of the shadow should touch one circle, you may perhaps catch it in touching another. The best time for drawing a meridian line, in this manner, is about the summer solstice; because the sun changes his declination slowest, and his altitude fastest in the longest days.

If the casement of a window, on which the sun shines at noon, be quite upright, you may draw a line along the edge of its shadow on the floor, when the shadow of the pin is exactly on the meridian line of the board; and as the motion of the shadow of the casement will be much more sensible on the floor, than that of the shadow of the pin on the board, you may know to a few seconds when it touches the meridian line on the floor; and so regulate your clock for the day of observation by that line and any good equation table.

As the equation of time, or difference between the time shewn by a well-regulated clock and a true sun-dial, depends upon two causes, namely, the obliquity of the ecliptic, and the unequal motion of the earth in it, we shall first explain the effects of these causes separately considered, and then the united effects resulting from their combination.

The earth's motion on its axis being perfectly equable, or always at the same rate, and the plane of the equator being perpendicular to its axis, it is evident, that in equal times equal portions of the equator pass over the meridian; and so would equal portions of the ecliptic, if it were parallel to or coincident with the equator. But, as the ecliptic is oblique to the equator, the equable motion of the earth carries unequal portions of the ecliptic over the meridian in equal times, the difference being proportionate to the obliquity; and, as some parts of the ecliptic are much more oblique than others, those differences are unequal among themselves. Therefore, if two suns should start either from the beginning of Aries or Libra, and continue to move through equal arcs in equal times, one in the equator, and the other in the ecliptic, the equatoreal sun would always run to the meridian in 24 hours time, as measured by a well-regulated clock; but the sun in the ecliptic would return to the meridian sometimes sooner, and sometimes later than the equatoreal sun; and only at the same moments with him on four days of the year; namely, the 20th of March, when the sun enters Aries; the 21st of June, when he enters Cancer; the 23d of September, when he enters

enters Libra; and the 21st of December, when he enters Capricorn. But, as there is only one sun, and his apparent motion is always on the ecliptic, let us henceforth call him the *real sun*; and the other, which is supposed to move in the equator, the *fictitious*; to which last, the motion of a well-regulated clock always answers.

In Plate XLII. fig. 4. let  $Z\varphi z$  be the earth,  $ZFRz$  its axis,  $abcde$  &c. the equator,  $ABCDE$  &c. the northern half of the ecliptic from  $\varphi$  or  $\Omega$  on the side of the globe next the eye; and  $MNOP$  &c. the southern half on the opposite side from  $\Omega$  to  $\varphi$ . Let the points at  $ABCDEF$  &c. quite round from  $\varphi$  to  $\varphi$  again bound equal portions of the ecliptic, gone through in equal times by the real sun; and those at  $abcdef$  &c. equal portions of the equator, described in equal times by the fictitious sun; and let  $Z\varphi z$  be the meridian.

As the real sun moves obliquely in the ecliptic, and the fictitious sun directly in the equator, with respect to the meridian; a degree, or any number of degrees, between  $\varphi$  and  $F$  on the ecliptic, must be nearer the meridian  $Z\varphi z$ , than a degree, or any corresponding number of degrees on the equator from  $\varphi$  to  $f$ ; and the more so, as they are the more oblique: And therefore the true sun comes sooner to the meridian every day whilst he is in the quadrant  $\varphi F$ , than the fictitious sun does in the quadrant  $\varphi f$ ; for which reason, the solar noon precedes noon by the clock, until the real sun comes to  $F$ , and the fictitious to  $f$ ; which two points, being equidistant from the meridian, both suns will come to it precisely at noon by the clock.

Whilst the real sun describes the second quadrant of the ecliptic  $FGHIKL$  from  $F$  to  $\Omega$ , he comes later to the meridian every day, than the fictitious sun moving through the second quadrant of the equator from  $f$  to  $\Omega$ ; for the points at  $GHIK$  and  $L$ , being farther from the meridian than their corresponding points at  $ghik$  and  $l$ , they must be later of coming to it: And as both suns come at the same moment to the point  $\Omega$ , they come to the meridian at the moment of noon by the clock.

In departing from Libra, through the third quadrants, the real sun going through  $MNOPQ$  towards  $rs$  at  $R$ , and the fictitious sun through  $mnoq$  towards  $r$ , the former comes to the meridian every day sooner than the latter, until the real sun comes to  $rs$ , and the fictitious to  $r$ , and then they both come to the meridian at the same time.

Lastly, as the real sun moves equably through  $STUVW$ , from  $rs$  towards  $\varphi$ ; and the fictitious sun thro'  $stuvw$ , from  $r$  towards  $\varphi$ ; the former comes later every day to the meridian than the latter, until they both arrive at the point  $\varphi$ , and then they make noon at the same time with the clock.

This part of the equation of time may perhaps be somewhat difficult to understand by a figure, because both halves of the ecliptic seem to be on the same side of the globe; but it may be made very easy to any person who has a real globe before him, by putting small patches on every tenth or fifteenth degree, both of the equator and ecliptic, beginning at Aries  $\varphi$ ; and then, turning the ball slowly round westward, he will see all

the patches from Aries to Cancer come to the brazen meridian sooner than the corresponding patches on the equator; all those from Cancer to Libra will come latter to the meridian than their corresponding patches on the equator; those from Libra to Capricorn sooner, and those from Capricorn to Aries latter: And the patches at the beginnings of Aries, Cancer, Libra, and Capricorn, being either on, or even with those on the equator, shew that the two suns either meet there, or are even with one another, and so come to the meridian at the same moment.

Let us suppose that there are two little balls moving equably round a celestial globe by clock-work, one always keeping in the ecliptic, and gilt with gold, to represent the real sun; and the other keeping in the equator, and silvered, to represent the fictitious sun: And that whilst these balls move once round the globe, according to the order of signs, the clock turns the globe 366 times round its axis westward. The stars will make 366 diurnal revolutions from the brazen meridian to it again; and the two balls representing the real and fictitious sun always going farther eastward from any given star, will come later than it to the meridian every following day; and each ball will make 365 revolutions to the meridian; coming equally to it at the beginnings of Aries, Cancer, Libra, and Capricorn: But in every other point of the ecliptic, the gilt ball will come either sooner or latter to the meridian than the silver ball, like the patches above mentioned.

This would be a pretty enough way of shewing the reason why any given star, which, on a certain day of the year, comes to the meridian with the sun, passes over it so much sooner every following day, as on that day twelvemonth to come to the meridian with the sun again; and also to shew the reason why the real sun comes to the meridian sometimes sooner, sometimes later, than it is noon by the clock; and, on four days of the year, at the same time; whilst the fictitious sun always comes to the meridian when it is twelve at noon by the clock. This would be no difficult task for an artist to perform; for the gold ball might be carried round the ecliptic by a wire from its north pole, and the silver ball round the equator by a wire from its south pole, by mean of a few wheels to each.

It is plain, that if the ecliptic were more obliquely posited to the equator, as the dotted circle  $\varphi\chi\Omega$ , the equal divisions from  $\varphi$  to  $\chi$  would come still sooner to the meridian  $Z\varphi$  than those marked  $ABCD$  and  $E$  do; for two divisions containing 30 degrees, from  $\varphi$  to the second dot, a little short of the figure 1, come sooner to the meridian than one division containing only 15 degrees from  $\varphi$  to  $A$  does, as the ecliptic now stands; and those of the second quadrant from  $\chi$  to  $\Omega$  would be so much later. The third quadrant would be as the first, and the fourth as the second. And it is likewise plain, that where the ecliptic is most oblique, namely, about Aries and Libra, the difference would be greatest; and least about Cancer and Capricorn, where the obliquity is least.

Having explained one cause of the difference of time shewn by a well-regulated clock and a true sun-dial; and considered the sun, not the earth, as moving in the ecliptic



ecliptic: We now proceed to explain the other cause of this difference, namely, the inequality of the sun's apparent motion, which is slowest in the summer, when the sun is farthest from the earth, and swiftest in winter when he is nearest to it. But the earth's motion on its axis is equable all the year round, and is performed from west to east; which is the way that the sun appears to change his place in the ecliptic.

If the sun's motion were equable in the ecliptic, the whole difference, between the equal time as shewn by a clock, and the unequal time as shewn by the sun, would arise from the obliquity of the ecliptic. But the sun's motion sometimes exceeds a degree in 24 hours, though generally it is less: And when his motion is slowest, any particular meridian will revolve sooner to him than when his motion is quickest; for it will overtake him in less time when he advances a less space than when he moves through a larger.

Now, if there were two suns moving in the plane of the ecliptic, so as to go round it in a year; the one describing an equal arc every 24 hours, and the other describing sometimes a less arc 24 hours, and at other times a larger, gaining at one time of the year what it lost at the opposite; it is evident that either of these suns would come sooner or latter to the meridian than the other, as it happened to be behind or before the other: and when they were both in conjunction, they would come to the meridian at the same moment.

As the real sun moves unequally in the ecliptic, let us suppose a fictitious sun to move equably in a circle coincident with the plane of the ecliptic. In Plate XLIII. fig. 1. let  $ABCD$  be the ecliptic or orbit in which the real sun moves, and the dotted circle  $abcd$  the imaginary orbit of the fictitious sun; each going round in a year according to the order of letters, or from west to east. Let  $HIKL$  be the earth turning round its axis the same way every 24 hours; and suppose both suns to start from  $A$  and  $a$ , in a right line with the plane of the meridian  $EH$ , at the same moment; the real sun at  $A$  being then at his greatest distance from the earth, at which time his motion is slowest; and the fictitious sun at  $a$ , whose motion is always equable, because his distance from the earth is supposed to be always the same. In the time that the meridian revolves from  $H$  to  $H$  again, according to the order of the letters  $HIKL$ , the real sun has moved from  $A$  to  $F$ ; and the fictitious with a quicker motion from  $a$  to  $f$ , through a larger arc. Therefore, the meridian  $EH$  will revolve sooner from  $H$  to  $b$  under the real sun at  $F$ , than from  $H$  to  $k$  under the fictitious sun at  $f$ ; and consequently it will then be noon by the sun-dial sooner than by the clock.

As the real sun moves from  $A$  towards  $C$ , the swiftness of his motion increases all the way to  $C$ , where it is at the quickest. But notwithstanding this, the fictitious sun gains so much upon the real, soon after his departing from  $A$ , that the increasing velocity of the real sun does not bring him up with the equally moving fictitious sun till the former comes to  $C$ , and the latter to  $c$ , when each has gone half round its respective orbit; and then being in conjunction, the meridian  $EH$  revolving to  $EK$  comes

to both suns at the same time, and therefore it is noon by them both at the same moment.

But the increasing velocity of the real sun, now being at the quickest, carries him before the fictitious one; and therefore, the same meridian will come to the fictitious sun sooner than to the real: For, whilst the fictitious sun moves from  $c$  to  $g$ , the real sun moves through a greater arc from  $C$  to  $G$ ; consequently the point  $K$  has its noon by the clock when it comes to  $k$ , but not its noon by the sun till it come to  $l$ . And although the velocity of the real sun diminishes all the way from  $C$  to  $A$ , and the fictitious sun by an equable motion is still coming nearer to the real sun, yet they are not in conjunction till the one comes to  $A$  and the other to  $a$ ; and then it is noon by them both at the same moment.

Thus it appears, that the solar noon is always later than noon by the clock, whilst the sun goes from  $C$  to  $A$ ; sooner whilst he goes from  $A$  to  $C$ ; and at these points the sun and clock being equal, it is noon by them both at the same moment.

The point  $A$  is called the sun's *apogee*, because when he is there he is at his greatest distance from the earth; the point  $C$  his *perigee*, because when in it he is at his least distance from the earth; and a right line, as  $AEC$ , drawn through the earth's centre, from one of these points to the other, is called *the line of the apses*.

The distance that the sun has gone in any time from his apogee (not the distance he has to go to it, though ever so little) is called his *mean anomaly*, and is reckoned in signs and degrees, allowing 30 degrees to a sign. Thus, when the sun has gone, suppose 174 degrees from his apogee at  $A$ , he is said to be 5 signs 24 degrees from it, which is his mean anomaly: And when he is gone, suppose 355 degrees from his apogee, he is said to be 11 signs 25 degrees from it, although he be but 5 degrees short of  $A$  in coming round to it again.

From what was said above, it appears, that when the sun's anomaly is less than 6 signs, that is, when he is any where between  $A$  and  $C$ , in the half  $ABC$  of his orbit, the solar noon precedes the clock noon; but when his anomaly is more than 6 signs, that is, when he is any where between  $C$  and  $A$ , in the half  $CDA$  of his orbit, the clock noon precedes the solar. When his anomaly is 0 signs 0 degrees, that is, when he is in his apogee at  $A$ ; or 6 signs 0 degrees, which is when he is in his perigee at  $C$ ; he comes to the meridian at the moment that the fictitious sun does, and then it is noon by them both at the same instant.

The obliquity of the ecliptic to the equator, which is the first mentioned cause of the equation of time, would make the sun and clocks agree on four days of the year; which are, when the sun enters Aries, Cancer, Libra, and Capricorn: But the other cause, now explained, would make the sun and clocks equal only twice a year; that is, when the sun is in his apogee and perigee. Consequently, when these two points fall in the beginnings of Cancer and Capricorn, or of Aries and Libra, they concur in making the sun and clocks equal in these points. But the apogee at present is in the 9th degree of Cancer,

and the perigee in the 9th degree of Capricorn, and therefore the sun and clocks cannot be equal about the beginning of these signs, nor at any time of the year, except when the swiftness or slowness of equation resulting from one cause just balances the slowness or swiftness arising from the other.

### CHAP. XII. *Of the Precession of the Equinoxes.*

It is a known fact, that there is a greater quantity of matter accumulated all round the equatorial parts of the earth than any where else.

The sun and moon, by attracting this redundancy of matter, bring the equator sooner under them in every return towards it, than if there was no such accumulation. Therefore, if the sun sets out, as from any star, or other fixed point in the heavens, the moment when he is departing from the equinoctial or from either tropic, he will come to the same equinox or tropic again 20 min.  $17\frac{1}{2}$  sec. of time, or 50 seconds of a degree, before he completes his course, so as to arrive at the same fixed star or point from whence he set out. For, the equinoctial points recede 50 seconds of a degree westward every year, contrary to the sun's annual progressive motion.

When the sun arrives at the same equinoctial or solstitial point, he finishes what we call the *tropical year*; which, by observation, is found to contain 365 days 5 hours 48 minutes 57 seconds: And, when he arrives at the same fixed star again, as seen from the earth, he completes the *sydereal year*, which contains 365 days 6 hours 9 minutes  $14\frac{1}{2}$  seconds. The sydereal year is therefore 20 minutes  $17\frac{1}{2}$  seconds longer than the solar or tropical year; and 9 minutes  $14\frac{1}{2}$  seconds longer than the Julian or civil year, which we state at 365 days

6 hours: So that the civil year is almost a mean betwixt the sydereal and tropical.

As the sun describes the whole ecliptic, or 360 degrees, in a tropical year, he moves 59 minutes 8 seconds of a degree every day at a mean rate; and consequently 50 seconds of a degree in 20 minutes  $17\frac{1}{2}$  seconds of time: Therefore, he will arrive at the same equinox or solstice when he is 50 seconds of a degree short of the same star or fixed point in the heavens from which he set out in the year before. So that, with respect to the fixed stars, the sun and equinoctial points fall back (as it were) 30 degrees in 2160 years; which will make the stars appear to have gone 30 degrees forward, with respect to the signs of the ecliptic in that time: For the same signs always keep in the same points of the ecliptic, without regard to the constellations.

To explain this by a figure, (Plate XLIII. fig. 1.) let the sun be in conjunction with a fixed star at *S*, suppose in the 30th degree of  $\gamma$  on the 21st of May 1756. Then, making 2160 revolutions through the ecliptic *VWX*, at the end of so many sydereal years, he will be found again at *S*: But at the end of so many Julian years, he will be found at *M*, short of *S*; and at the end of so many tropical years, he will be found short of *M* in the 30th degrees of Taurus at *T*, which has receded back from *S* to *T* in that time, by the precession of the equinoctial points  $\gamma$  Aries and  $\omega$  Libra. The arc *ST* will be equal to the amount of the precession of the equinox in 2160 years, at the rate of 50 seconds of a degree, or 20 minutes  $17\frac{1}{2}$  seconds of time, annually: This, in so many years, makes 30 days  $10\frac{1}{2}$  hours; which is the difference between 2160 sydereal and tropical years: And the arc *MT* will be equal to the space moved through by the sun in 2160 times 11 minutes 3 seconds, or 16 days 13 hours 48 minutes, which is the difference between 2160 Julian and tropical years.

*A TABLE shewing the Precession of the Equinoctial Points in the Heavens, both in Motion and Time; and the Anticipation of the Equinoxes on Earth.*

Julian years.	Precession of the Equinoxial Points in the Heavens.				Anticipation of the Equinoxes on the Earth.							
	Motion.				Time.							
	s	o	'	"	Days.	H.	M.	S.	D.	H.	M.	S.
1	0	0	0	50	0	0	20	17½	0	0	11	3
2	0	0	1	40	0	0	40	35	0	0	22	6
3	0	0	2	30	0	1	0	52½	0	0	33	9
4	0	0	3	20	0	1	21	10	0	0	44	12
5	0	0	4	10	0	1	41	27½	0	0	55	15
6	0	0	5	0	0	2	1	45	0	1	6	18
7	0	0	5	50	0	2	22	2½	0	1	17	21
8	0	0	6	40	0	2	42	20	0	1	28	24
9	0	0	7	30	0	3	2	37½	0	1	39	27
10	0	0	8	20	0	3	22	55	0	1	50	30
20	0	0	16	40	0	6	45	50	0	3	41	0
30	0	0	25	0	0	10	8	45	0	5	31	30
40	0	0	33	20	0	13	31	40	0	7	22	0
50	0	0	41	40	0	16	54	35	0	9	12	30
60	0	0	50	0	0	20	17	30	0	11	3	0
70	0	0	58	20	0	23	40	25	0	12	53	30
80	0	1	6	40	1	3	3	20	0	14	44	0
90	0	1	15	0	1	6	26	15	0	16	34	30
100	0	1	23	20	1	9	49	10	0	18	25	0
200	0	2	46	40	2	19	38	20	1	12	50	0
300	0	4	10	0	4	5	27	30	2	7	15	0
400	0	5	33	20	5	15	16	40	3	1	40	0
500	0	6	56	40	7	1	5	50	3	20	5	0
600	0	8	20	0	8	10	55	0	4	14	30	0
700	0	9	43	20	9	20	44	10	5	8	55	0
800	0	11	6	40	11	6	33	20	6	3	20	0
900	0	12	30	0	12	16	22	30	6	21	45	0
1000	0	13	53	20	14	2	11	40	7	16	10	0
2000	0	27	46	40	28	4	23	20	15	8	20	0
3000	1	11	40	0	42	6	35	0	23	0	30	0
4000	1	25	33	20	56	8	46	40	30	16	40	0
5000	2	9	26	40	70	10	58	20	38	8	50	0
6000	2	23	20	0	84	13	10	0	46	1	0	0
7000	3	7	13	20	98	15	21	40	53	17	10	0
8000	3	21	6	40	112	17	33	20	61	9	20	0
9000	4	5	0	0	126	19	45	0	69	1	30	0
10000	4	18	53	20	140	21	56	40	76	17	40	0
20000	9	7	46	40	281	19	53	20	153	11	20	0
25920	12	0	0	0	365	6	0	0	198	21	36	0

From

From the shifting of the equinoctial points, and with them all the signs of the ecliptic, it follows, that those stars which, in the infancy of astronomy, were in Aries, are now got into Taurus; those of Taurus into Gemini, &c. Hence likewise it is, that the stars which rose or set at any particular season of the year, in the times of Hesiod, Eudoxius, Virgil, Pliny, &c. by no means answer at this time to their descriptions. The preceding table shews the quantity of this shifting both in the heavens and on the earth, for any number of years to 25,920, which compleats the grand celestial period; within which any number and its quantity is easily found,

as in the following example, for 5763 years; which, at the autumnal equinox, *A. D.* 1756, is thought to be the age of the world. So that with regard to the fixed stars, the equinoctial points in the heavens have receded  $2^{\circ} 20' 30''$  since the creation; which is as much as the sun moves in  $81^{\text{d}} 5^{\text{h}} 0^{\text{m}} 52^{\text{s}}$ . And since that time, or in 5763 years, the equinoxes with us have fallen back  $44^{\text{d}} 5^{\text{h}} 21^{\text{m}} 9^{\text{s}}$ ; hence, reckoning from the time of the Julian equinox, *A. D.* 1756, *viz.* Sept. 11th, it appears, that the autumnal equinox at the creation was on the 25th of October.

Julian years.	Precession of the Equinoctial Points in the Heavens.				Anticipation of the Equinoxes on the Earth.							
	Motion.				Time.							
	s	o	'	"	D.	H.	M.	S.	D.	H.	M.	S.
5000	2	9	26	40	70	10	58	20	38	8	50	0
700	0	9	43	20	9	20	44	10	5	8	55	0
60	0	0	50	0	0	20	17	30	0	11	3	0
3	0	0	2	30	0	1	0	52	0	0	33	9
5763	2	20	2	30	81	5	0	52	44	5	21	9

The anticipation of the equinoxes, and consequently of the seasons, is by no means owing to the precession of the equinoctial and solstitial points in the heavens, (which can only affect the apparent motions, places, and declinations of the fixed stars), but to the difference between the civil and solar year, which is 11 minutes 3 seconds; the civil year containing 365 days 6 hours, and the solar year 365 days 5 hours 48 minutes 57 seconds.

The above 11 minutes 3 seconds, by which the civil or Julian year exceeds the solar, amounts to 11 days in 1433 years; and so much our seasons have fallen back with respect to the days of the months, since the time of the Nicene Council in *A. D.* 325, and therefore in order to bring back all the fasts and festivals to the days then settled, it was requisite to suppress 11 nominal days. And that the same seasons might be kept to the same times of the year for the future, to leave out the bissextile day in February at the end of every century of years not divisible by 4; reckoning them only common years, as the 17th, 18th, and 19th centuries, *viz.* the years 1700, 1800, 1900, &c. because a day intercalated every fourth year was too much, and retaining the bissextile-day at the end of those centuries of years which are divisible by 4, as the 16th, 20th, and 24th centuries, *viz.* the years 1600, 2000, 2400, &c. Otherwise, in length of time, the seasons would be quite reversed with regard to the months of the year; though it would have required near 23,783 years to have brought about such a total change. If the earth had made exactly  $365\frac{1}{4}$  diurnal rotations on its axis, whilst it revolved from any equinoctial or solstitial point to the same again, the civil and solar years would always have kept pace together, and the style would never have needed any alteration.

Having already mentioned the cause of the precession of the equinoctial points in the heavens, which occasions a slow deviation of the earth's axis from its parallelism, and thereby a change of the declination of the stars from the equator, together with a slow apparent motion of the stars forward with respect to the signs of the ecliptic; we shall now describe the phenomena by a diagram.

In Plate XLIII. fig. 2. let *NZSVL* be the earth, *SONA* its axis produced to the starry heavens, and terminating in *A*, the present north pole of the heavens, which is vertical to *N* the north pole of the earth. Let *EOQ* be the equator, *TSEZ* the tropic of Cancer, and *VTS* the tropic of Capricorn; *VOZ* the ecliptic, and *BO* its axis, both which are immovable among the stars. But as the equinoctial points recede in the ecliptic, the earth's axis *SON* is in motion upon the earth's centre *O*, in such a manner as to describe the double cone *NON* and *SOI*, round the axis of the ecliptic *BO*, in the time that the equinoctial points move quite round the ecliptic, which is 25,920 years; and in that length of time, the north pole of the earth's axis produced, describes the circle *ABCD* in the starry heavens, round the pole of the ecliptic, which keeps immovable in the centre of that circle. The earth's axis being  $23\frac{1}{4}$  degrees inclined to the axis of the ecliptic, the circle *ADCDA*, described by the north pole of the earth's axis produced to *A*, is 47 degrees in diameter, or double the inclination of the earth's axis. In consequence of this, the point *A*, which at present is the north pole of the heavens, and near to a star of the second magnitude in the tail of the constellation called the *Little Bear*, must be deserted by the earth's axis, which moving backwards a degree every 72 years, will be directed towards the star or point *B* in

6480 years hence; and in double of that time, or 12,960 years, it will be directed towards the star or point *C*; which will then be the north pole of the heavens, although it is at present  $8\frac{1}{2}$  degrees south of the zenith of London *L*. The present position of the equator *EOQ*, will then be changed into *eOq*; the tropic of Cancer *TQZ*, into *VtQ*; and the tropic of Capricorn *VTrs*, into *trsZ*; as is evident by the figure. And the sun, in the same part of the heavens where he is now over the earthly tropic of Capricorn, and makes the shortest days and longest nights in the northern hemisphere, will then be over the earthly tropic of Cancer, and make the days longest and nights shortest. So that it will require 12,960 years yet more, or 25,920 from the present time, to bring the north pole *N* quite round, so as to be directed towards that point of the heavens which is vertical to it at present. And then, and not till then, the same stars which at present describe the equator, tropics, and polar circles, &c. by the earth's diurnal motion, will describe them over again.

CHAP. XIII. *The moon's surface mountainous: Her phases described: Her path and the paths of Jupiter's moons delineated: The proportions of the diameters of their orbits, and those of Saturn's moons, to each other, and to the diameter of the Sun.*

By looking at the moon with an ordinary telescope, we perceive that her surface is diversified with long tracts of prodigious high mountains and deep cavities. Some of her mountains, by comparing their height with her diameter (which is 2180 miles) are found to be three times higher than the highest hills on our earth. This ruggedness of the moon's surface is of great use to us, by reflecting the sun's light to all sides; for if the moon were smooth and polished like a looking-glass, or covered with water, she could never distribute the sun's light all round; only in some positions she would shew us his image no bigger than a point, but with such a lustre as would be hurtful to our eyes.

The moon's surface being so uneven, many have wondered why her edge appears not jagged, as well as the curve bounding the light and dark places. But if we consider, that what we call the edge of the moon's disk is not a single line set round with mountains, in which case it would appear irregularly indented, but a large zone having many mountains lying behind one another from the observer's eye, we shall find that the mountains in some rows will be opposite to the vales in others, and so fill up the inequalities as to make her appear quite round; just as when one looks at an orange, although its roughness be very discernible on the side next the eye, especially if the sun or a candle shines obliquely on that side, yet the line terminating the visible part still appears smooth and even.

As the sun can only enlighten that half of the earth which is at any moment turned towards him, and being withdrawn from the opposite half, leaves it in darkness;

so he likewise doth to the moon; only with this difference, that the earth being surrounded by an atmosphere, and the moon having none, we have twilight after the sun sets; but the lunar inhabitants have an immediate transition from the brightest sun-shine to the blackest darkness. For, (Plate XLIII. fig. 3.) let *thrsw* be the earth, and *ABCDEFGH* the moon in eight different parts of her orbit. As the earth turns round its axis from west to east, when any place comes to *t* the twilight begins there, and when it revolves from thence to *r* the sun *S* rises; when the place comes to *s* the sun sets, and when it comes to *w* the twilight ends. But as the moon turns round her axis, which is only once a-month, the moment that any point of her surface comes to *r* (see the moon at *G*) the sun rises there without any previous warning by twilight; and when the same point comes to *s* the sun sets, and that point goes into darkness as black as at midnight.

The moon being an opaque spherical body, (for her hills take off no more from her roundness than the inequalities on the surface of an orange takes off from its roundness), we can only see that part of the enlightened half of her which is towards the earth. And therefore, when the moon is at *A*, in conjunction with the sun *S*, her dark half is towards the earth; and she disappears, as at *a*, there being no light on that half to render it visible. When she comes to her first octant at *B*, or has gone an eighth part of her orbit from her conjunction, a quarter of her enlightened side is towards the earth, and she appears horned, as at *b*. When she has gone a quarter of her orbit from between the earth and sun to *C*, she shews us one half of her enlightened side, as at *c*, and we say, she is a quarter old. At *D* in her second octant, and by shewing us more of her enlightened side she appears gibbous, as at *d*. At *E* her whole enlightened side is towards the earth, and therefore she appears round, as at *e*, when we say, it is full moon. In her third octant at *F*, part of her dark side being towards the earth, she again appears gibbous, and is on the decrease, as at *f*. At *G* we see just one half of her enlightened side, and she appears half decreased, or in her third quarter, as at *g*. At *H* we only see a quarter of her enlightened side, being in her fourth octant, where she appears horned, as at *h*. And at *A*, having completed her course from the sun to the sun again, she disappears, and we say, it is new moon. Thus in going from *A* to *E*, the moon seems continually to increase; and in going from *E* to *A*, to decrease in the same proportion; having like phases at equal distances from *A* or *E*, but as seen from the sun *S*, she is always full.

The moon appears not perfectly round when she is full in the highest or lowest part of her orbit, because we have not a full view of her enlightened side at that time. When full in the highest part of her orbit, a small deficiency appears on her lower edge; and the contrary when full in the lowest part of her orbit.

It is plain by the figure, that when the moon changes to the earth, the earth appears full to the moon; and *vice versa*. For when the moon is at *A*, new to the earth, the whole enlightened side of the earth is towards the moon; and when the moon is at *E*, full to the earth,

its dark side is towards her. Hence a new moon answers to a full earth, and a full moon to a new earth. The quarters are also reversed to each other.

Between the third quarter and change, the moon is frequently visible in the forenoon, even when the sun shines; and then she affords us an opportunity of seeing a very agreeable appearance, where-ever we find a globular stone above the level of the eye, as suppose on the top of a gate. For, if the sun shines on the stone, and we place ourselves so as the upper part of the sun may just seem to touch the point of the moon's lowermost horn, we shall then see the enlightened part of the stone exactly of the same shape with the moon, horned as she is, and inclining the same way to the horizon. The reason is plain, for the sun enlightens the stone the same way as he does the moon; and both being globes, when we put ourselves into the above situation, the moon and stone have the same position to our eyes, and therefore we must see as much of the illuminated part of the one as of the other.

The position of the moon's cusps, or a right line touching the points of her horns, is very differently inclined to the horizon at different hours of the same days of her age. Sometimes she stands, as it were, upright on her lower horn, and then such a line is perpendicular to the horizon: when this happens, she is in what the astronomers call the *nonagesimal degree*, which is the highest point of the ecliptic above the horizon at that time, and is 90 degrees from both sides of the horizon, where it is then cut by the ecliptic. But this never happens when the moon is on the meridian, except when she is at the very beginning of Cancer or Capricorn.

The inclination of that part of the ecliptic to the horizon in which the moon is at any time when horned, may be known by the position of her horns; for a right line touching their points is perpendicular to the ecliptic. And as the angle that the moon's orbit makes with the ecliptic can never raise her above, nor depress her below the ecliptic, more than two minutes of a degree, as seen from the sun, it can have no sensible effect upon the position of her horns. Therefore, if a quadrant be held up, so as one of its edges may seem to touch the moon's horns, the graduated side being kept towards the eye, and as far from the eye as it can be conveniently held, the arc between the plumb-line and that edge of the quadrant which seems to touch the moon's horns, will shew the inclination of that part of the ecliptic to the horizon. And the arc between the other edge of the quadrant and plumb-line will shew the inclination of the moon's horns to the horizon.

The moon generally appears as large as the sun; for the angle  $\nu k A$ , (Plate XLIII. fig. 3.) under which the moon is seen from the earth, is the same with the angle  $L k M$ , under which the sun is seen from it. And therefore the moon may hide the sun's whole disk from us, as she sometimes does in solar eclipses. The reason why she does not eclipse the sun at every change shall be explained afterwards. If the moon were farther from the earth, as at  $a$ , she could never hide the whole of the sun from us; for then she would appear under the angle  $N k O$ , eclipsing only that part of the sun which lies between  $N$  and  $O$ : were she

still further from the earth, as at  $X$ , she would appear under the small angle  $T k W$ , like a spot on the sun, hiding only the part  $T W$  from our sight.

The moon turns round her axis in the time that she goes round her orbit; which is evident from hence, that a spectator at rest, without the periphery of the moon's orbit, would see all her sides turned regularly towards him in that time. She turns round her axis from any star to the same star again in 27 days 8 hours; from the sun to the sun again in  $29\frac{1}{2}$  days: the former is the length of the syderal day, and the latter the length of her solar day. A body moving round the sun would have a solar day in every revolution, without turning on its axis, the same as if it had kept all the while at rest, and the sun moved round it; but without turning round its axis it could never have one syderal day, because it would always keep the same side towards any given star.

If the earth had no annual motion, the moon would go round it so as to complete a lunation, a syderal, and a solar day, all in the same time. But, because the earth goes forward in its orbit, while the moon goes round the earth in her orbit, the moon must go as much more than round her orbit from change to change in completing a solar day, as the earth has gone forward in its orbit during that time, *i. e.* almost a twelfth part of a circle.

The moon's periodical and synodical revolution may be familiarly represented by the motions of the hour and minute-hands of a watch round its dial-plate, which is divided into 12 equal parts or hours, as the ecliptic is divided into 12 signs, and the year into 12 months. Let us suppose these 12 hours to be 12 signs, the hour-hand the sun, and the minute-hand the moon; then will the former go round once in a year, and the latter once in a month; but the moon, or minute-hand, must go more than round from any point of the circle where it was last conjoined with the sun, or hour-hand, to overtake it again: For the hour-hand being in motion, can never be overtaken by the minute-hand at that point from which they started at their last conjunction.

If the earth had no annual motion, the moon's motion round the earth, and her track in absolute space, would be always the same. But as the earth and moon move round the sun, the moon's real path in the heavens is very different from her visible path round the earth; the latter being in a progressive circle, and the former in a curve of different degrees of concavity, which would always be the same in the same parts of the heavens, if the moon performed a complete number of lunations in a year without any thing over.

Let a nail in the end of the axle of a chariot-wheel represent the earth, and a pin in the nave the moon; if the body of the chariot be propped up so as to keep that wheel from touching the ground, and the wheel be then turned round by hand, the pin will describe a circle both round the nail, and in the space it moves through. But if the props be taken away, the horses put to, and the chariot driven over a piece of ground which is circularly convex, the nail in the axle will describe a circular curve, and the pin in the nave will still describe a circle round the progressive nail in the axle, but not in the space through which it moves. In this case, the curve described

described by the nail will resemble in miniature as much of the earth's annual path round the sun, as it describes whilst the moon goes as often round the earth as the pin does round the nail; and the curve described by the nail will have some resemblance of the moon's path during so many lunations.

Let us now suppose that the radius of the circular curve described by the nail in the axle is to the radius of the circle which the pin in the nave describes round the axle, as  $33\frac{1}{2}$  to 1; which is the proportion of the radius or semidiameter of the earth's orbit to that of the moon's, or of the circular curve  $A\ 1\ 2\ 3\ 4\ 5\ 6\ 7\ B$ , &c. to the little circle  $a$ ; and then, whilst the progressive nail describes the said curve from  $A$  to  $E$ , the pin will go once round the nail with regard to the centre of its path, and in so doing, will describe the curve  $abcde$ . The former will be a true representation of the earth's path for one lunation, and the latter of the moon's for that time. Here we may set aside the inequalities of the moon's motion, and also the earth's moving round its common centre of gravity and the moon's: All which, if they were truly copied in this experiment, would not sensibly alter the figure of the paths described by the nail and pin, even though they should rub against a plain upright surface all the way, and leave their tracks visible upon it. And if the chariot was driven forward on such a convex piece of ground, so as to turn the wheel several times round, the track of the pin in the nave would still be concave toward the centre of the circular curve described by the pin in the axle; as the moon's path is always concave to the sun in the centre of the earth's annual orbit.

In this diagram, the thickest curve line  $ABCD$ , with the numeral figures set to it, represents as much of the earth's annual orbit as it describes in 32 days from west to east; the little circles at  $abcde$  shew the moon's orbit in due proportion to the earth's; and the smallest curve  $abcdef$  represents the line of the moon's path in the heavens for 32 days, accounted from any particular new moon at  $a$ . The machine, Plate XLIX. fig. 9. is for delineating the moon's path, and will be described, with the rest of the astronomical machinery, in the last chapter. The sun is supposed to be in the centre of the curve  $A\ 1\ 2\ 3\ 4\ 5\ 6\ 7\ B$ , &c. and the small dotted circles upon it represent the moon's orbit, of which the radius is in the same proportion to the earth's path in this scheme, that the radius of the moon's orbit in the heavens bears to the radius of the earth's annual path round the sun; that is, as 240,000 to 81,000,000, or as 1 to  $33\frac{1}{2}$ .

When the earth is at  $A$ , the new moon is at  $a$ ; and in the seven days that the earth describes the curve  $1\ 2\ 3\ 4\ 5\ 6\ 7$ , the moon, in accompanying the earth describes the curve  $ab$ ; and is in her first quarter at  $b$  when the earth is at  $B$ . As the earth describes the curve  $B\ 8\ 9\ 10\ 11\ 12\ 13\ 14$ , the moon describes the curve  $bc$ ; and is at  $c$ , opposite to the sun, when the earth is at  $C$ . Whilst the earth describes the curve  $C\ 15\ 16\ 17\ 18\ 19\ 20\ 21\ 22$ , the moon describes the curve  $cd$ ; and is in her third quarter at  $d$  when the earth is at  $D$ . Once more, whilst the earth describes the curve  $D\ 23\ 24\ 25\ 26\ 27\ 28\ 29$ , the moon describes

the curve  $de$ , and is again in conjunction at  $e$  with the sun when the earth is at  $E$ , between the 29th and 30th day of the moon's age, accounted by the numeral figures from the new moon at  $A$ . In describing the curve  $abcde$ , the moon goes round the progressive earth as really as if she had kept in the dotted circle  $A$ , and the earth continued immoveable in the centre of that circle.

And thus we see, that although the moon goes round the earth in a circle, with respect to the earth's centre, her real path in the heavens is not very different in appearance from the earth's path. To shew that the moon's path is concave to the sun, even at the time of change, it is carried on a little farther into a second lunation, as to  $f$ .

The moon's absolute motion from her change to her first quarter, or from  $a$  to  $b$ , is so much slower than the earth's, that she falls 240 thousand miles (equal to the semidiameter of her orbit) behind the earth at her first quarter in  $b$ , when the earth is in  $B$ ; that is, she falls back a space equal to her distance from the earth. From that time her motion is gradually accelerated to her opposition or full at  $c$ , and then she is come up as far as the earth, having regained what she lost in her first quarter from  $a$  to  $b$ . From the full to the last quarter at  $d$ , her motion continues accelerated, so as to be just as far before the earth at  $D$ , as she was behind it at her first quarter in  $b$ . But, from  $d$  to  $e$  her motion is retarded so, that she loses as much with respect to the earth as is equal to her distance from it, or to the semidiameter of her orbit; and by that means she comes to  $e$ , and is then in conjunction with the sun, as seen from the earth at  $E$ . Hence we find, that the moon's absolute motion is slower than the earth's from her third quarter to her first; and swifter than the earth's from her first quarter to her third: Her path being less curved than the earth's in the former case, and more in the latter. Yet it is still bent the same way towards the sun; for if we imagine the concavity of the earth's orbit to be measured by the length of a perpendicular line  $Cg$ , let down from the earth's place upon the straight line  $bgd$  at the full of the moon, and connecting the places of the earth at the end of the moon's first and third quarters, that length will be about 640 thousand miles; and the moon, when newly approaching nearer to the sun by 240 thousand miles than the earth is, the length of the perpendicular let down from her place at that time upon the same straight line, and which shews the concavity of that part of her path, will be about 400 thousand miles.

The moon's path being concave to the sun throughout, demonstrates that her gravity towards the sun, at her conjunction, exceeds her gravity towards the earth. And if we consider that the quantity of matter in the sun is almost 230 thousand times as great as the quantity of matter in the earth, and that the attraction of each body diminishes as the square of the distance from it increases, we shall soon find, that the point of equal attraction between the earth and the sun is about 70 thousand miles nearer the earth than the moon is at her change. It may now appear surprising, that the moon does not abandon the earth when she is between it and the sun, because she is considerably more attracted by the sun than by the earth.

earth at that time. But this difficulty vanishes when we consider, that a common impulse on any system of bodies affects not their relative motions; but that they will continue to attract, impel, or circulate round one another, in the same manner as if there was no such impulse. The moon is so near the earth, and both of them so far from the sun, that the attractive power of the sun may be considered as equal on both; and therefore, the moon will continue to circulate round the earth in the same manner as if the sun did not attract them at all; like bodies in the cabin of a ship, which move round, or impel one another, in the same manner when the ship is under sail, as when it is at rest, because they are all equally affected by the common motion of the ship. If by any other cause, such as the near approach of a comet, the moon's distance from the earth should happen to be so much increased, that the difference of their gravitating forces towards the sun should exceed that of the moon towards the earth; in that case, the moon, when in conjunction, would abandon the earth, and be either drawn into the sun, or comet, or circulate round about it.

The curves which Jupiter's satellites describe, are all of different sorts from the path described by our moon, although these satellites go round Jupiter, as the moon goes round the earth. In Plate XLIII. fig. 3. let *ABCDE*, &c. be as much of Jupiter's orbit as he describes in 18 days from *A* to *T*; and the curves *abcd* will be the paths of his four moons going round him in his progressive motion.

Now let us suppose all these moons to set out from a conjunction with the sun, as seen from Jupiter at *A*; then his first or nearest moon will be at *a*, his second at *b*, his third at *c*, and his fourth at *d*. At the end of 24 terrestrial hours after this conjunction, Jupiter has moved to *B*, his first moon or satellite has described the curve *a1*, his second the curve *b1*, his third *c1*, and his fourth *d1*. The next day, when Jupiter is at *C*, his first satellite has described the curve *a2*, from its conjunction, his second the curve *b2*, his third the curve *c2*, and his fourth the curve *d2*, and so on. The numeral figures under the capital letters shew Jupiter's place in his path every day for 18 days, accounted from *A* to *T*; and the like figures set to the paths of his satellites, shew where they are at the like times. The first satellite, almost under *C*, is stationary at  $\dagger$  as seen from the sun; and retrograde from  $\dagger$  to 2: at 2 it appears stationary again, and thence it moves forward until it has past 3, and is twice stationary, and once retrograde, between 3 and 4. The path of this satellite intersects itself every  $42\frac{1}{2}$  hours, making such loops as in the diagram at 2 3 5 7 9 10 12 14 16 18, a little after every conjunction. The second satellite *b*, moving slower, barely crosses its path every 3 days 13 hours; as at 4 7 11 14 18, making only five loops and as many conjunctions in the time that the first makes ten. The third satellite *c* moving still slower, and having described the curve *c* 1 2 3 4 5 6 7, comes to an angle at 7 in conjunction with the sun at the end of 7 days 4 hours; and so goes on to describe such another curve 7 8 9 10 11 12 13 14, and is at 14 in its next conjunction. The

fourth satellite *d* is always progressive, making neither loops nor angles in the heavens; but comes to its next conjunction at *e* between the numeral figures 16 and 17, or in 16 days 18 hours. In order to have a tolerably good figure of the paths of these satellites, take the following method.

It appears by the scheme, that the three first satellites come almost into the same line or position every seventh day; the first being only a little behind with the second, and the second behind with the third. But the period of the fourth satellite is so incommensurate to the periods of the other three, that it cannot be guessed at by the diagram when it would fall again into a line of conjunction with them, between Jupiter and the sun. And no wonder; for supposing them all to have been once in conjunction, it will require 3,087,043,493,260 years to bring them in conjunction again.

In Plate XLIV. fig. 1. we have the proportions of the orbits of Saturn's five satellites, and of Jupiter's four, to one another, to our moon's orbit, and to the disk of the sun. *S* is the sun; *M m* the moon's orbit, (the earth supposed to be at *E*); *J* Jupiter; 1 2 3 4 the orbits of his four moons or satellites; *Sat* Saturn; and 1 2 3 4 5 the orbits of his five moons. Hence it appears, that the sun would much more than fill the whole orbit of the moon; for the sun's diameter is 763,000 miles, and the diameter of the moon's orbit only 480,000. In proportion to all these orbits of the satellites, the radius of Saturn's annual orbit would be  $21\frac{1}{2}$  yards, of Jupiter's orbit  $11\frac{1}{2}$ , and of the earth's  $2\frac{1}{2}$ , taking them in round numbers.

#### CHAP. XIV. *The Phenomena of the Harvest-moon explained by a common Globe: The years in which the Harvest-moons are least and most beneficial from 1751, to 1861. The long Duration of Moon-light at the Poles in Winter.*

It is generally believed that the moon rises about 48 minutes later every day than on the preceding; but this is true only with regard to places on the equator. In places of considerable latitude there is a remarkable difference, especially in the harvest time; with which farmers were better acquainted than astronomers till of late; and gratefully ascribed the early rising of the full moon at that time of the year to the goodness of God, in ordering it so on purpose to give them an immediate supply of moon-light after sun-set for their greater convenience in reaping the fruits of the earth. And indeed,

In this instance of the harvest-moon, as in many others discoverable by astronomy, the wisdom and beneficence of the Deity is conspicuous, who really ordered the course of the moon so, as to bestow more or less light on all parts of the earth as their several circumstances and seasons render it more or less serviceable. About the equator, where there is no variety of seasons, and the weather changes seldom, and at stated times, moon-light is not necessary for gathering in the produce of the ground;



Fig. 1.

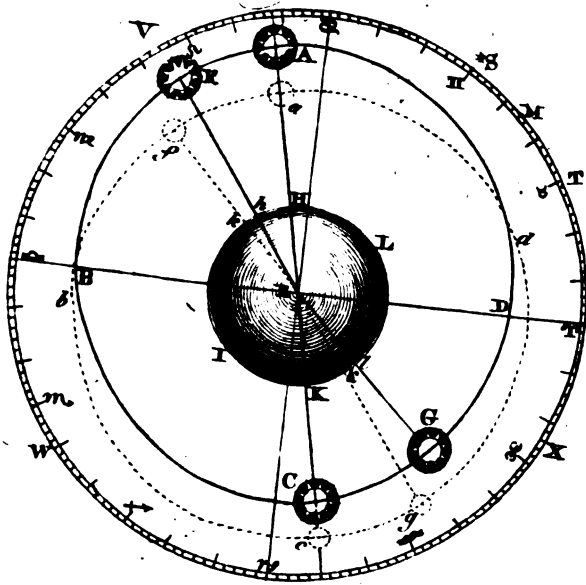


Fig. 2.

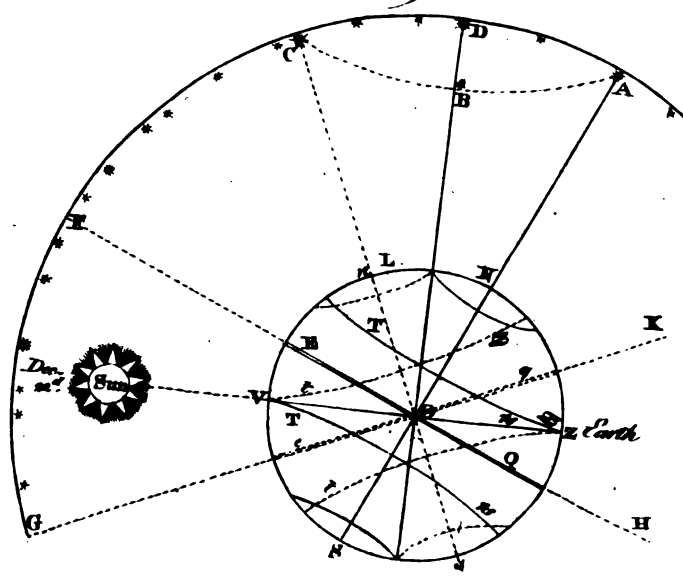


Fig. 3.

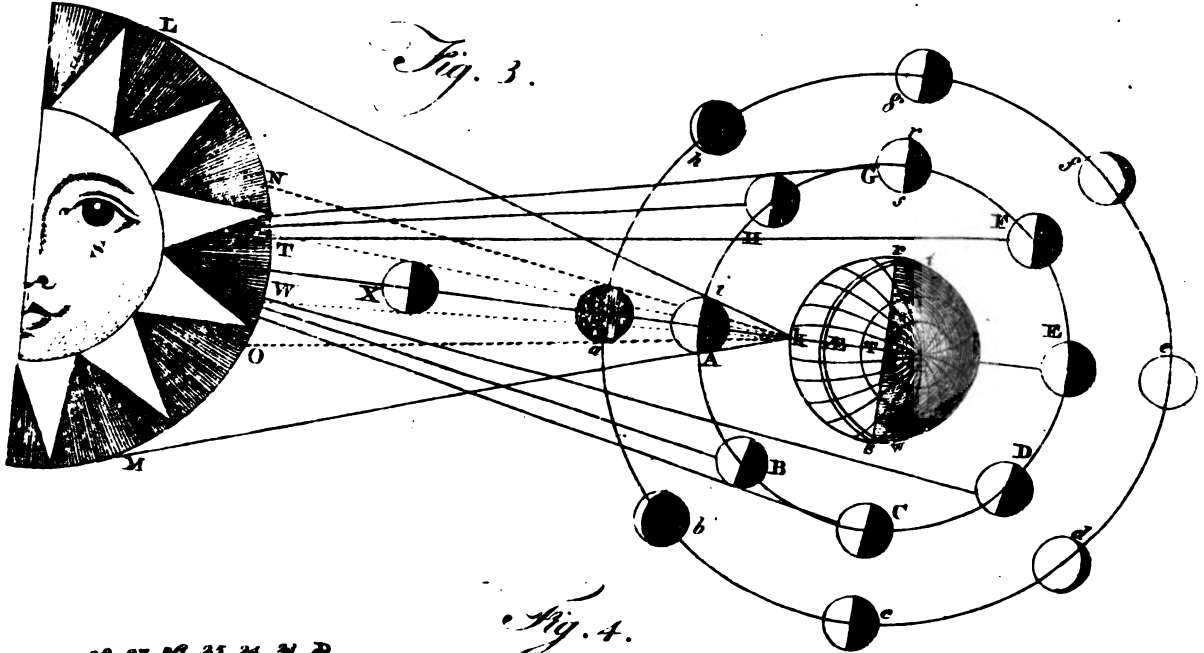


Fig. 4.

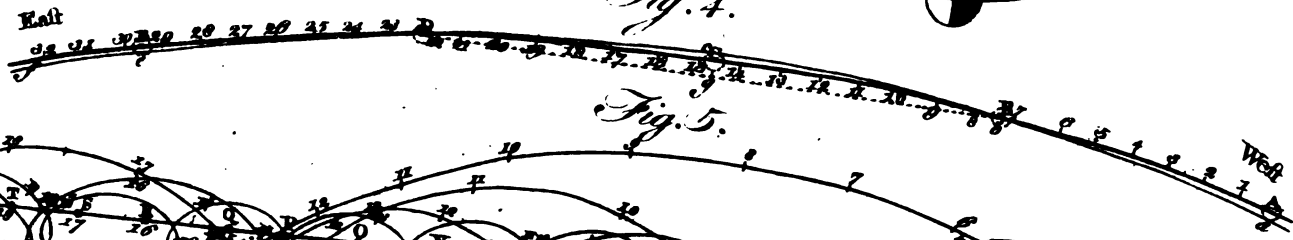
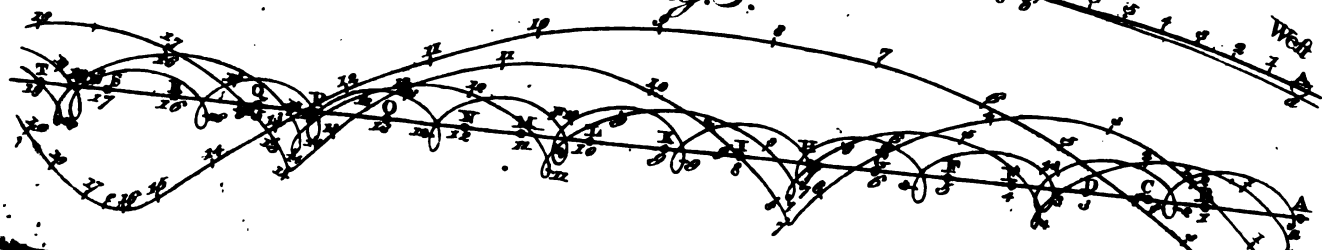


Fig. 5.





ground; and there the moon rises about 48 minutes later every day or night than on the former. At considerable distances from the equator, where the weather and seasons are more uncertain, the autumnal full moons rise very soon after sun-set for several evenings together. At the polar circles, where the mild season is of very short duration, the autumnal full moon rises at sun-set from the first to the third quarter. And at the poles, where the sun is for half a year absent, the winter full moons shine constantly without setting from the first to the third quarter.

It is soon said that all these phenomena are owing to the different angles made by the horizon and different parts of the moon's orbit; and that the moon can be full but once or twice in a year in those parts of her orbit which rise with the least angles. But to explain this subject intelligibly, we must dwell much longer upon it.

The plane of the equinoctial is perpendicular to the earth's axis: and therefore, as the earth turns round its axis, all parts of the equinoctial make equal angles with the horizon both at rising and setting; so that equal portions of it always rise or set in equal times. Consequently, if the moon's motion were equable, and in the equinoctial, at the rate of 12 degrees from the sun every day, as it is in her orbit, she would rise and set 48 minutes later every day than on the preceding: for 12 degrees of the equinoctial rise or set in 48 minutes of time in all latitudes.

But the moon's motion is so nearly in the ecliptic, that we may consider her at present as moving in it. Now the different parts of the ecliptic, on account of its obliquity to the earth's axis, make very different angles with the horizon as they rise or set. Those parts or signs which rise with the smallest angles set with the greatest, and *vice versa*. In equal times, whenever this angle is least, a greater portion of the ecliptic rises than when the angle is larger; as may be seen by elevating the pole of a globe to any considerable latitude, and then turning it round its axis in the horizon. Consequently, when the moon is in those signs which rise or set with the smallest angles, she rises or sets with the least difference of time; and with the greatest difference in those signs which rise or set with the greatest angles.

But, because all who read this treatise may not be provided with globes, though in this case it is requisite to know how to use them, we shall substitute the figure of a globe; (Plate XLIV. fig. 2.) in which *FUP* is the axis, *STR* the tropic of Cancer, *LTrs* the tropic of Capricorn, *EURs* the ecliptic touching both the tropics, which are 47 degrees from each other, and *AB* the horizon. The equator, being in the middle between the tropics, is cut by the ecliptic in two opposite points, which are the beginnings of  $\varphi$  Aries and  $\omega$  Libra. *K* is the hour-circle with its index, *F* the north pole of the globe elevated to a considerable latitude, suppose 40 degrees above the horizon, and *P* the south pole depressed as much below it. Because of the oblique position of the sphere in this latitude, the ecliptic has the high elevation *NU* above the horizon, making the angle *NU* of  $73\frac{1}{2}$  degrees with it when  $\omega$  Cancer is on the meridian, at which time  $\omega$  Libra rises in the

east. But let the globe be turned half round its axis till *rs* Capricorn comes to the meridian and  $\varphi$  Aries rises in the east, and then the ecliptic will have the low elevation *NL* above the horizon, making only an angle *NUL* of  $26\frac{1}{2}$  degrees with it; which is 47 degrees less than the former angle, equal to the distance between the tropics.

In northern latitudes, the smallest angle made by the ecliptic and horizon is when Aries rises, at which time Libra sets; the greatest when Libra rises, at which time Aries sets. From the rising of Aries to the rising of Libra, (which is twelve syderal hours), the angle increases; and from the rising of Libra to the rising of Aries, it decreases in the same proportion. By this article and the preceding, it appears that the ecliptic rises fastest about Aries, and slowest about Libra.

On the parallel of London, as much of the ecliptic rises about Pisces and Aries in two hours as the moon goes through in six days; and therefore whilst the moon is in these signs, she differs but two hours in rising for six days together; that is, about 20 minutes later every day or night than on the preceding, at a mean rate. But in 14 days afterwards, the moon comes to Virgo and Libra, which are the opposite signs to Pisces and Aries; and then she differs almost four times as much in rising; namely, one hour and about fifteen minutes later every day or night than the former, whilst she is in these signs.

All these things will be made plain by putting small patches on the ecliptic of a globe, as far from one another as the moon moves from any point of the celestial ecliptic in 24 hours, which at a mean rate is  $13\frac{1}{2}$  degrees; and then in turning the globe round, observe the rising and setting of the patches in the horizon, as the index points out the different times in the hour-circle. A few of these patches are represented by dots at *o 1 2 3, &c.* on the ecliptic, which has the position *LUI* when Aries rises in the east; and by the dots *o 1 2 3, &c.* when Libra rises in the east; at which time the ecliptic has the position *EURs*; making an angle of 62 degrees with the horizon in the latter case, and an angle of no more than 15 degrees with it in the former; supposing the globe rectified to the latitude of London.

Having rectified the globe, turn it until the patch at *o*, about the beginning of  $\chi$  Pisces in the half *LUI* of the ecliptic, comes to the eastern side of the horizon; and then keeping the ball steady, set the hour-index to XII, because *that* hour may perhaps be more easily remembered than any other. Then turn the globe round westward, and in that time, suppose the patch *o* to have moved thence to 1,  $13\frac{1}{2}$  degrees, whilst the earth turns once round its axis, and you will see that 1 rises only about 20 minutes later than *o* did on the day before. Turn the globe round again, and in that time suppose the same patch to have moved from 1 to 2; and it will rise only 20 minutes later by the hour-index than it did at 1 on the day or turn before. At the end of the next turn, suppose the patch to have gone from 2 to 3 at *U*, and it will rise 20 minutes later than it did at 2. And so on for six turns, in which time there will scarce be two hours difference: nor would there have been so n u h if

the 6 degrees of the sun's motion in that time had been allowed for. At the first turn the patch rises south of the east, at the middle turn due east, and at the last turn north of the east. But these patches will be 9 hours of setting on the western side of the horizon, which shews that the moon will be so much later of setting in that week in which she moves through these two signs. The cause of this difference is evident; for Pisces and Aries make only an angle of 15 degrees with the horizon when they rise; but they make an angle of 62 degrees with it when they set. As the signs Taurus, Gemini, Cancer, Leo, Virgo, and Libra, rise successively, the angle increases gradually which they make with the horizon; and decreases in the same proportion as they set. And for that reason, the moon differs gradually more in the time of her rising every day whilst she is in these signs, and less in her setting: after which, through the other six signs, *viz.* Scorpio, Sagittary, Capricorn, Aquarius, Pisces, and Aries, the rising difference becomes less every day, until it be at the least of all, namely, in Pisces and Aries.

The moon goes round the ecliptic in 27 days 8 hours; but not from change to change in less than 29 days 12 hours: so that she is in Pisces and Aries at least once in every lunation, and in some lunations twice.

If the earth had no annual motion, the sun would never appear to shift his place in the ecliptic. And then every new moon would fall in the same sign and degree of the ecliptic, and every full moon in the opposite; for the moon would go precisely round the ecliptic from change to change. So that if the moon was once full in Pisces or Aries, she would always be full when she came round to the same sign and degree again. And as the full moon rises at sun-set (because when any point of the ecliptic sets, the opposite point rises) she would constantly rise within two hours of sun-set, on the parallel of London, during the week in which she were full. But in the time that the moon goes round the ecliptic from any conjunction or opposition, the earth goes almost a sign forward; and therefore the sun will seem to go as far forward in that time, namely,  $27\frac{1}{2}$  degrees; so that the moon must go  $27\frac{3}{4}$  degrees more than round, and as much farther as the sun advances in that interval, which is  $2\frac{1}{4}$  degrees, before she can be in conjunction with, or opposite to, the sun again. Hence it is evident, that there can be but one conjunction or opposition of the sun and moon in a year in any particular part of the ecliptic. This may be familiarly exemplified by the hour and minute-hands of a watch, which are never in conjunction or opposition in that part of the dial-plate where they were so last before. And indeed, if we compare the twelve hours on the dial-plate to the twelve signs of the ecliptic, the hour-hand to the sun, and the minute-hand to the moon, we shall have a tolerably near resemblance in miniature to the motions of our great celestial luminaries. The only difference is, that whilst the sun goes once round the ecliptic, the moon makes  $12\frac{1}{2}$  conjunctions with him: but whilst the hour hand goes round the dial-plate, the minute-hand makes only 11 conjunctions with it; because the minute-hand moves slower in respect of the hour-hand than the moon does with regard to the sun.

As the moon can never be full but when she is opposite to the sun, and the sun is never in Virgo and Libra but in our autumnal months, it is plain that the moon is never full in the opposite signs, Pisces and Aries, but in these two months. And therefore we can have only two full moons in the year, which rise so near the time of sun-set, for a week together, as above mentioned. The former of these is called the *harvest-moon*, and the latter the *hunter's moon*.

Here it will probably be asked, 'Why we never observe this remarkable rising of the moon but in harvest, since she is in Pisces and Aries twelve times in the year besides; and must then rise with as little difference of time as in harvest? The answer is plain: for in winter these signs rise at noon; and being then only a quarter of a circle distant from the sun, the moon in them is in her first quarter: But when the sun is above the horizon, the moon's rising is neither regarded nor perceived. In spring these signs rise with the sun, because he is then in them; and as the moon changeth in them at that time of the year, she is quite invisible. In summer they rise about midnight, and the sun being then three signs, or a quarter of a circle before them, the moon is in them about her third quarter; when rising so late, and giving but very little light, her rising passes unobserved. And in autumn, these signs, being opposite to the sun, rise when he sets, with the moon in opposition, or at the full, which makes her rising very conspicuous.

At the equator, the north and south poles lie in the horizon; and therefore the ecliptic makes the same angle southward with the horizon when Aries rises, as it does northward when Libra rises. Consequently, as the moon at all the fore-mentioned patches rises and sets nearly at equal angles with the horizon all the year round, and about 48 minutes later every day or night than on the preceding, there can be no particular harvest-moon at the equator.

The farther that any place is from the equator, if it be not beyond the polar circle, the angle gradually diminishes which the ecliptic and horizon make when Pisces and Aries rise: And therefore, when the moon is in these signs she rises with a nearly proportionable difference later every day than on the former; and is for that reason the more remarkable about the full, until we come to the polar circles, or 66 degrees from the equator; in which latitude the ecliptic and horizon become coincident every day for a moment, at the same syderal hour, (or 3 minutes 56 seconds sooner every day than the former), and the very next moment one half of the ecliptic, containing Capricorn, Aquarius, Pisces, Aries, Taurus, and Gemini rises, and the opposite half sets. Therefore, whilst the moon is going from the beginning of Capricorn to the beginning of Cancer, which is almost 14 days, she rises at the same syderal hour; and in autumn, just at sun-set, because all that half of the ecliptic, in which the sun is at that time, sets at the same syderal hour, and the opposite half rises; that is, 3 minutes 56 seconds, of mean solar time, sooner every day than on the day before. So, whilst the moon is going from Capricorn to Cancer, she rises earlier every day than on the preceding, contrary to what she does at all places.

places between the polar circles. But, during the above fourteen days, the moon is 24 sydereal hours later in setting; for the six signs, which rise all at once on the eastern side of the horizon, are 24 hours in setting on the western side of it; as any one may see by making chalk-marks at the beginning of Capricorn and of Cancer, and then, having elevated the pole  $66\frac{1}{2}$  degrees, turn the globe slowly round its axis, and observe the rising and setting of the ecliptic. As the beginning of Aries is equally distant from the beginning of Cancer and of Capricorn, it is in the middle of that half of the ecliptic which rises all at once. And when the sun is at the beginning of Libra, he is in the middle of the other half. Therefore, when the sun is in Libra, and the moon in Capricorn, the moon is a quarter of a circle before the sun; opposite to him, and consequently full in Aries, and a quarter of a circle behind him, when in Cancer. But when Libra rises, Aries sets, and all that half of the ecliptic of which Aries is the middle; and therefore, at that time of the year, the moon rises at sun-set from her first to her third quarter.

In northern latitudes, the autumnal full moons are in Pisces and Aries, and the vernal full moons in Virgo and Libra: In southern latitudes just the reverse, because the seasons are contrary. But Virgo and Libra rise at as small angles with the horizon in southern latitudes, as Pisces and Aries do in the northern; and therefore the harvest-moons are just as regular on one side of the equator as on the other.

As these signs, which rise with the least angles, set with the greatest, the vernal full moons differ as much in their times of rising every night, as the autumnal full moons differ in their times of setting; and set with as little difference as the autumnal full moons rise; the one being in all cases the reverse of the other.

Hitherto, for the sake of plainness, we have supposed the moon to move in the ecliptic, from which the sun never deviates. But the orbit in which the moon really moves is different from the ecliptic; one half being elevated  $5\frac{1}{2}$  degrees above it, and the other half as much depressed below it. The moon's orbit therefore intersects the ecliptic in two points diametrically opposite to each other; and these intersections are called the *moon's nodes*. So the moon can never be in the ecliptic but when she is in either of her nodes, which is at least twice in every course from change to change, and sometimes thrice. For, as the moon goes almost a whole sign more than round her orbit from change to change, if she passes by either node about the time of change, she will pass by the other in about fourteen days after, and come round to the former node two days again before the next change. That node, from which the moon begins to ascend northward, or above the ecliptic, in northern latitudes, is called the *ascending node*; and the other, the *descending node*; because the moon, when she passes by it, descends below the ecliptic southward.

The moon's oblique motion, with regard to the eclip-

tic, causes some difference in the times of her rising and setting from what is already mentioned. For whilst she is northward of the ecliptic, she rises sooner and sets later than if she moved in the ecliptic; and when she is southward of the ecliptic, she rises later, and sets sooner. This difference is variable, even in the same signs, because the nodes shift backward about  $19\frac{1}{2}$  degrees in the ecliptic every year; and so go round it contrary to the order of signs in 18 years 225 days.

When the ascending node is in Aries, the southern half of the moon's orbit makes an angle of  $5\frac{1}{2}$  degrees less with the horizon than the ecliptic does, when Aries rises in northern latitudes: For which reason the moon rises with less difference of time whilst she is in Pisces and Aries, than there would be if she kept in the ecliptic. But in 9 years and 112 days afterward, the descending node comes to Aries; and then the moon's orbit makes an angle  $5\frac{1}{2}$  degrees greater with the horizon when Aries rises, that the ecliptic does at that time; which causes the moon to rise with greater difference of time in Pisces and Aries than if she moved in the ecliptic.

To be a little more particular; when the ascending node is in Aries, the angle is only  $9\frac{3}{4}$  degrees on the parallel of London when Aries rises. But when the descending node comes to Aries, the angle is  $20\frac{1}{4}$  degrees; this occasions as great a difference of the moon's rising in the same signs every 9 years, as there would be on two parallels to  $10\frac{3}{4}$  degrees from one another, if the moon's course were in the ecliptic.

As there is a complete revolution of the nodes in  $18\frac{3}{4}$  years, there must be a regular period of all the varieties which can happen in the rising and setting of the moon during that time. But this shifting of the nodes never affects the moon's rising so much, even in her quickest descending latitude, as not to allow us still the benefit of her rising nearer the time of sun-set for a few days together about the full in harvest, than when she is full at any other time of the year. The following table shews in what years the harvest-moons are least beneficial as to the times of their rising, and in what years most, from 1751 to 1861. The column of years under the letter L are those in which the harvest-moons are least of all beneficial, because they fall about the descending node; and those under M are the most of all beneficial, because they fall about the ascending node. In all the columns from N to S, the harvest-moons descend gradually in the lunar orbit, and rise to less heights above the horizon. From S to N they ascend in the same proportion, and rise to greater heights above the horizon. In both the columns under S, the harvest-moons are in the lowest part of the moon's orbit, that is, farthest south of the ecliptic; and therefore stay shortest of all above the horizon; in the columns under N, just the reverse. And, in both cases, their rising, though not at the same times, are nearly the same with regard to difference of time, as if the moon's orbit were coincident with the ecliptic.

Years

*Years in which the Harvest-moons are least beneficial.*

N				L				S	
1751	1752	1753	1754	1755	1756	1757	1758	1759	
1770	1771	1772	1773	1774	1775	1776	1777	1778	
1788	1789	1790	1791	1792	1793	1794	1795	1796	1797
1807	1808	1809	1810	1811	1812	1813	1814	1815	
1826	1827	1828	1829	1830	1831	1832	1833	1834	
1844	1845	1846	1847	1848	1849	1850	1851	1852	

*Years in which they are most beneficial.*

S				M				N	
1760	1761	1762	1763	1764	1765	1766	1767	1768	1769
1779	1780	1781	1782	1783	1784	1785	1786	1787	
1798	1799	1800	1801	1802	1803	1804	1805	1806	
1816	1817	1818	1819	1820	1821	1822	1823	1824	1825
1835	1836	1837	1838	1839	1840	1841	1842	1843	
1853	1854	1855	1856	1857	1858	1859	1860	1861	

At the polar circles, when the sun touches the summer tropic, he continues 24 hours above the horizon, and 24 hours below it when he touches the winter tropic. For the same reason, the full moon neither rises in summer, nor sets in winter, considering her as moving in the ecliptic. For the winter full moon being as high in the ecliptic as the summer sun, must therefore continue as long above the horizon; and the summer full moon being as low in the ecliptic as the winter sun, can no more rise than he does. But these are only the two full moons which happen about the tropics, for all the others rise and set. In summer, the full moons are low, and their stay is short above the horizon, when the nights are short, and we have least occasion for moon-light: In winter, they go high, and stay long above the horizon, when the nights are long, and we want the greatest quantity of moon-light.

At the poles, one half of the ecliptic never sets, and the other half never rises; and therefore, as the sun is always half a year in describing one half of the ecliptic, and as long in going through the other half, it is natural to imagine that the sun continues half a year together above the horizon of each pole in its turn, and as long below it, rising to one pole when he sets to the other. This would be exactly the case if there were no refraction; but by the atmosphere's refracting the sun's rays, he becomes visible some days sooner, and continues some days longer in sight than he would otherwise do: so that he appears above the horizon of either pole before he has got below the horizon of the other. And as he never goes more than  $23\frac{1}{2}$  degrees below the horizon of the poles, they have very little dark night; it being twilight there as well as at all other places till the sun be 18 degrees below the horizon. The full moon being always opposite to the sun, can never be seen while the sun is above the horizon, except when the moon falls in the northern half of her orbit; for whenever any point of the ecliptic rises, the opposite point sets. Therefore, as the sun is above the horizon of the north pole from the 20th of March till the 23d of September, it is plain, that the moon, when full, being opposite to the sun, must

be below the horizon during that half of the year. But when the sun is in the southern half of the ecliptic, he never rises to the north pole, during which half of the year, every full moon happens in some part of the northern half of the ecliptic, which never sets. Consequently, as the polar inhabitants never see the full moon in summer, they have her always in the winter, before, at, and after the full, shining for 14 of our days and nights. And when the sun is at his greatest depression below the horizon, being then in Capricorn, the moon is at her first quarter in Aries, full in Cancer, and at her third quarter in Libra. And as the beginning of Aries is the rising point of the ecliptic, Cancer the highest, and Libra the setting point, the moon rises at her first quarter in Aries, is most elevated above the horizon, and full in Cancer, and sets at the beginning of Libra in her third quarter, having continued visible for 14 diurnal rotations of the earth. Thus the poles are supplied one half of the winter time with constant moon-light in the sun's absence; and only lose sight of the moon from her third to her first quarter, while she gives but very little light, and could be but of little, and sometimes of no service to them. A bare view of the figure (Plate XLIV. fig. 3.) will make this plain; in which let *S* be the sun, *e* the earth in summer when its north pole *n* inclines toward the sun, and *E* the earth in winter, when its north pole declines from him. *SEN* and *NWS* is the horizon of the north pole, which is coincident with the equator; and, in both these positions of the earth, *VSQR* is the moon's orbit, in which she goes round the earth according to the order of the letters *abcd*, *ABCD*. When the moon is at *a*, she is in her third quarter to the earth at *e*, and just rising to the north pole *n*; at *b* she changes, and is at the greatest height above the horizon, as the sun likewise is; at *c* she is in her first quarter, setting below the horizon; and is lowest of all under it at *d*, when opposite to the sun, and her enlightened side toward the earth. But then she is full in view to the south pole *p*, which is as much turned from the sun as the north pole inclines towards him. Thus, in our summer, the moon is above the horizon of the north pole

Fig. 1.

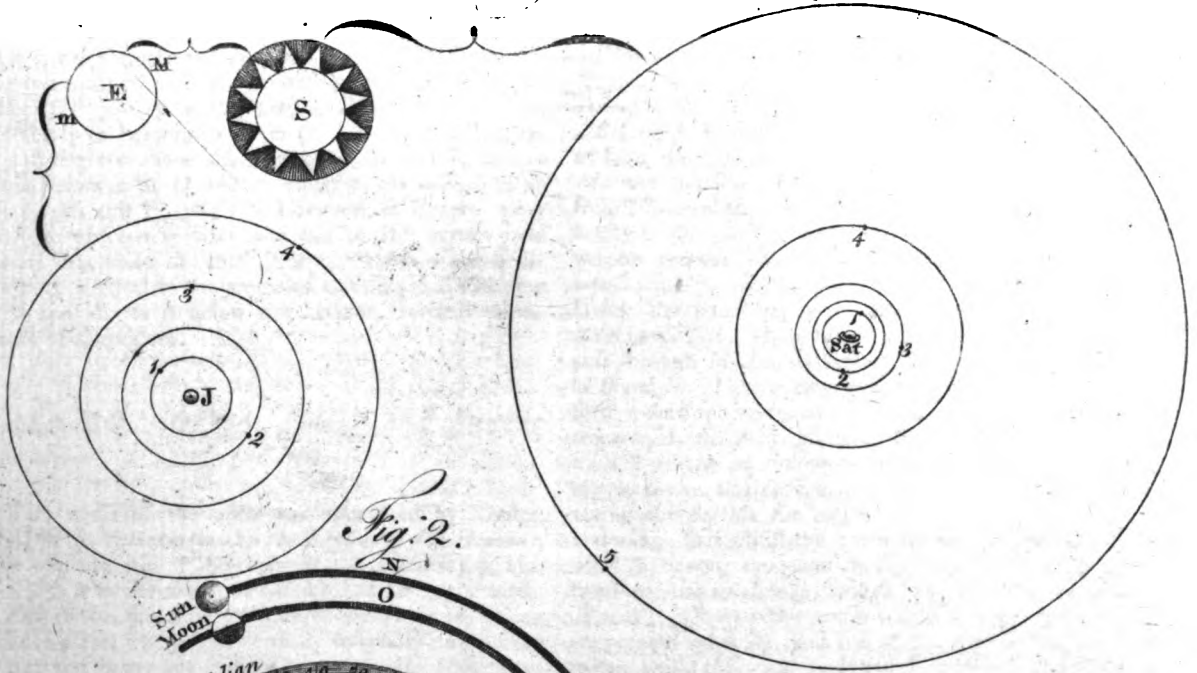


Fig. 2.



Fig. 4.

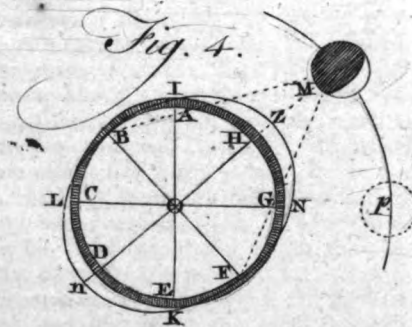
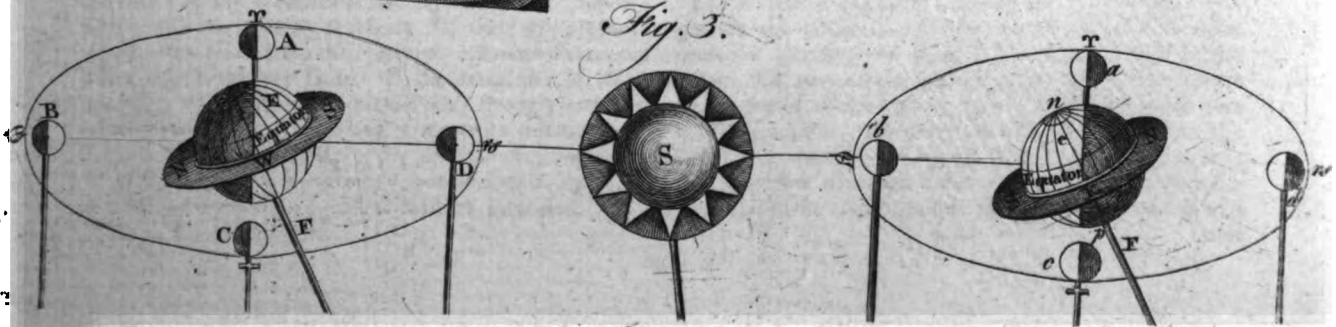


Fig. 3.







pole whilst she describes the northern half of the ecliptic  $\varphi \text{ } \text{ } \varphi$ , or from her third quarter to her first; and below the horizon during her progress through the southern half  $\varphi \text{ } \text{ } \varphi$ ; highest at the change, most depressed at the full. But in winter, when the earth is at  $E$ , and its north pole declines from the sun, the new moon at  $D$  is at her greatest depression below the horizon  $NWS$ , and the full moon at  $B$  at her greatest height above it, rising at her first quarter  $A$ , and keeping above the horizon till she comes to her third quarter  $C$ . At a mean state she is  $23\frac{1}{4}$  degrees above the horizon at  $B$  and  $b$ , and as much below it at  $D$  and  $d$ , equal to the inclination of the earth's axis  $F$ .  $S\text{ } \text{ } S$  and  $Sr$  are, as it were, a ray of light proceeding from the sun to the earth; and shews, that when the earth is at  $e$ , the sun is above the horizon, vertical to the tropic of Cancer; and when the earth is at  $E$ , he is below the horizon, vertical to the tropic of Capricorn.

CHAP. XV. *Of the Ebbing and Flowing of the Sea.*

THE cause of the tides was discovered by Kepler, who, in his *Introduction to the Physics of the Heavens*, thus explains it: "The orb of the attracting power, which is in the moon, is extended as far as the earth, and draws the waters under the torrid zone, acting upon places where it is vertical, insensibly on confined seas and bays, but sensibly on the ocean, whose beds are large, and the waters have the liberty of recipro- cation; that is, of rising and falling." And in the 70th page of his *Lunar Astronomy*:—"But the cause of the tides of the sea appears to be the bodies of the sun and moon drawing the waters of the sea." This hint being given, Sir Isaac Newton improved it, and wrote so amply on the subject, as to make the theory of the tides in a manner quite his own; by discovering the cause of their rising on the side of the earth opposite to the moon. For Kepler believed, that the presence of the moon occasioned an impulse which caused another in her absence.

The power of gravity diminishes as the square of the distance increases; and therefore the waters (Plate XLIV. fig. 4.) at  $Z$  on the side of the earth  $ABCDEFGH$  next the moon  $M$  are more attracted than the central parts of the earth  $O$  by the moon, and the central parts are more attracted by her than the waters on the opposite side of the earth at  $n$ ; and therefore the distance between the earth's centre and the waters on its surface under and opposite to the moon will be increased. For, let there be three bodies at  $H$ ,  $O$ , and  $D$ , if they are all equally attracted by the body  $M$ , they will all move equally fast toward it, their mutual distances from each other continuing the same. If the attraction of  $M$  is unequal, then that body which is most strongly attracted will move fastest, and this will increase its distance from the other body. Therefore, by the law of gravitation,  $M$  will attract  $H$  more strongly than it does  $O$ , by which the distance between  $H$  and  $O$  will be increased, and a

spectator on  $O$  will perceive  $H$  rising higher toward  $Z$ . In like manner,  $O$  being more strongly attracted than  $D$ , it will move farther towards  $M$  than  $D$  does; consequently the distance between  $O$  and  $D$  will be increased, and a spectator on  $O$ , not perceiving his own motion, will see  $D$  receding farther from him towards  $n$ ; all effects and appearances being the same, whether  $D$  recedes from  $O$ , or  $O$  from  $D$ .

Suppose now there is a number of bodies, as  $ABCDEFGH$ , placed round  $O$ , so as to form a flexible or fluid ring; then, as the whole is attracted towards  $M$ , the parts at  $H$  and  $D$  will have their distance from  $O$  increased; whilst the parts at  $B$  and  $F$ , being nearly at the same distance from  $M$  as  $O$  is, these parts will not recede from one another, but rather, by the oblique attraction of  $M$ , they will approach nearer to  $O$ . Hence the fluid ring will form itself into an ellipse  $ZIBLpKFNZ$ , whose longer axis  $nOZ$  produced will pass through  $M$ , and its shorter axis  $BOF$  will terminate in  $B$  and  $F$ . Let the ring be filled with bodies, so as to form a fluid sphere round  $G$ ; then, as the whole moves toward  $M$ , the fluid sphere being lengthened at  $Z$  and  $n$ , will assume an oblong or oval form. If  $M$  is the moon,  $O$  the earth's centre,  $ABCDEFGH$  the sea covering the earth's surface, it is evident, by the above reasoning, that whilst the earth by its gravity falls toward the moon, the water directly below her at  $B$  will swell and rise gradually towards her; also the water at  $D$  will recede from the centre, (strictly speaking the centre recedes from  $D$ ), and rise on the opposite side of the earth, whilst the water at  $B$  and  $F$  is depressed, and falls below the former level. Hence, as the earth turns round its axis from the moon to the moon again in  $24\frac{1}{4}$  hours, there will be two tides of flood and two of ebb in that time, as we find by experience.

As this explanation of the ebbing and flowing of the sea is deduced from the earth's constantly falling toward the moon by the power of gravity, some may find a difficulty in conceiving how this is possible, when the moon is full, or in opposition to the sun, since the earth revolves about the sun, and must continually fall towards it, and therefore cannot fall contrary ways at the same time; or if the earth is constantly falling towards the moon, they must come together at last. To remove this difficulty, let it be considered, that it is not the centre of the earth that describes the annual orbit round the sun, but the common centre of gravity of the earth and moon together; and that whilst the earth is moving round the sun, it also describes a circle round that centre of gravity, going as many times round it in one revolution about the sun as there are lunations or courses of the moon round the earth in a year; and therefore the earth is constantly falling towards the moon from a tangent to the circle it describes round the said common centre of gravity. In Plate XLV. fig. 1. let  $M$  be the moon,  $TW$  part of the moon's orbit, and  $C$  the centre of gravity of the earth and moon; whilst the moon goes round her orbit, the centre of the earth describes the circle  $ged$  round  $C$ , to which circle  $gak$  is a tangent; and therefore when the moon has gone from  $M$  to a little past  $W$ , the earth has moved from  $g$  to  $e$ ; and in that

time has fallen towards the moon, from the tangent at  $a$  to  $e$ , and so round the whole circle.

The sun's influence in raising the tides is but small in comparison of the moon's: For though the earth's diameter bears a considerable proportion to its distance from the moon, it is next to nothing when compared with the distance of the sun. And therefore, the difference of the sun's attraction on the sides of the earth under and opposite to him, is much less than the difference of the moon's attraction on the sides of the earth under and opposite to her; and therefore the moon must raise the tides much higher than they can be raised by the sun.

On this theory, so far as we have explained it, the tides ought to be highest directly under and opposite to the moon; that is, when the moon is due north and south. But we find, that in open seas, where the water flows freely, the moon  $M$  (Plate XLIV. fig. 4.) is generally past the north and south meridian, as at  $p$ , when it is high water at  $Z$  and at  $n$ . The reason is obvious; for though the moon's attraction was to cease altogether when she was past the meridian, yet the motion of ascent communicated to the water before that time would make it continue to rise for some time after; much more must it do so when the attraction is only diminished: as a little impulse given to a moving ball will cause it still to move farther than otherwise it could have done. And as experience shews, that the day is hotter about three in the afternoon, than when the sun is on the meridian, because of the increment made to the heat already imparted.

The tides answer not always to the same distance of the moon from the meridian at the same places, but are variously affected by the action of the sun, which brings them on sooner when the moon is in her first and third quarters, and keeps them back later when she is in her second and fourth; because in the former case the tide raised by the sun alone would be earlier than the tide raised by the moon, and in the latter case later.

The moon goes round the earth in an elliptic orbit, and therefore she approaches nearer to the earth than her mean distance, and recedes farther from it, in every lunar month. When she is nearest, she attracts strongest, and so raises the tides most; the contrary happens when she is farthest, because of her weaker attraction. When both luminaries are in the equator, and the moon in *Perrigeo*, or at her least distance from the earth, she raises the tides highest of all, especially at her conjunction and opposition; both because the equatorial parts have the greatest centrifugal force from their describing the largest circle, and from the concurring actions of the sun and moon. At the change, the attractive forces of the sun and moon being united, they diminish the gravity of the waters under the moon, and their gravity on the opposite side is diminished by means of a greater centrifugal force. At the full, whilst the moon raises the tide under and opposite to her, the sun acting in the same line, raises the tide under and opposite to him; whence their conjoint effect is the same as at the change; and in both cases, occasion what we call the *spring-tides*. But at the quarters, the sun's action on the waters at  $O$  and  $H$  (Plate XLV. fig. 2.) diminishes the effect of the moon's action on the waters at  $Z$  and  $N$ ; so that they rise a

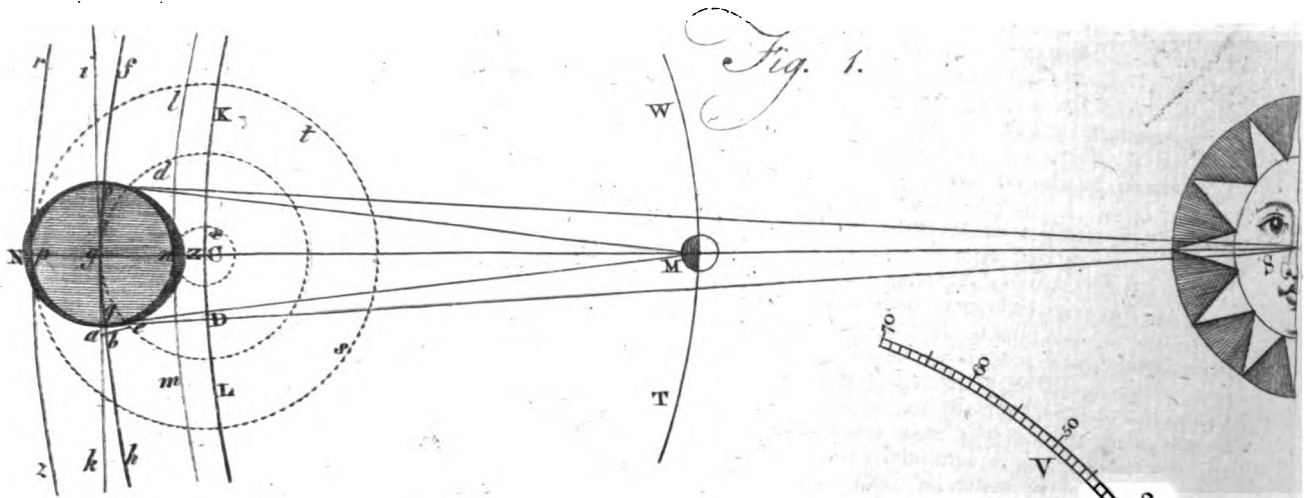
little under and opposite to the sun at  $O$  and  $H$ , and fall as much under and opposite to the moon at  $Z$  and  $N$ , making what we call the *neap-tides*, because the sun and moon then act cross-wise to each other. But, strictly speaking, these tides happen not till some time after; because in this, as in other cases, the actions do not produce the greatest effect when they are at the strongest, but some time afterward.

The sun being nearer the earth in winter than in summer, is of course nearer to it in February and October than in March and September; and therefore the greatest tides happen not till some time after the autumnal equinox, and return a little before the vernal.

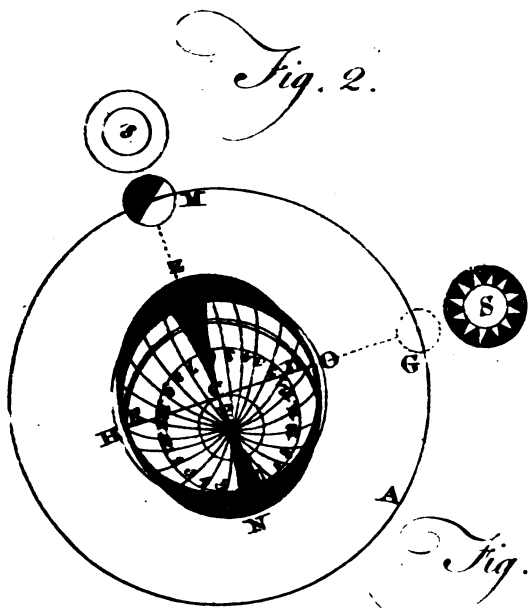
The sea being thus put in motion, would continue to ebb and flow for several times, even though the sun and moon were annihilated, or their influence should cease: as if a basin of water were agitated, the water would continue to move for some time after the basin was left to stand still. Or like a pendulum, which having been put in motion by the hand, continues to make several vibrations without any new impulse.

When the moon is in the equator, the tides are equally high in both parts of the lunar day, or time of the moon's revolving from the meridian to the meridian again, which is 24 hours 48 minutes. But as the moon declines from the equator towards either pole, the tides are alternately higher and lower at places having north or south latitude. For one of the highest elevations, which is that under the moon, follows her towards the pole to which she is nearest, and the other declines towards the opposite pole; each elevation describing parallels as far distant from the equator, on opposite sides, as the moon declines from it to either side; and consequently, the parallels described by these elevations of the water are twice as many degrees from one another, as the moon is from the equator; increasing their distance as the moon increases her declination, till it be at the greatest, when the said parallels are, at a mean state, 47 degrees from one another: and on that day, the tides are most unequal in their heights. As the moon returns toward the equator, the parallels described by the opposite elevations approach towards each other, until the moon comes to the equator, and then they coincide. As the moon declines toward the opposite pole, at equal distances, each elevation describes the same parallel in the other part of the lunar day, which its opposite elevation described before. Whilst the moon has north declination, the greatest tides in the northern hemisphere are when she is above the horizon; and the reverse whilst her declination is south. In Plate XLV. let  $NESQ$  be the earth,  $NCS$  its axis,  $EQ$  the equator,  $T\text{C}$  the tropic of Cancer,  $tr$  the tropic of Capricorn,  $ab$  the arctic circle,  $cd$  the antarctic,  $N$  the north pole,  $S$  the south pole,  $M$  the moon,  $F$  and  $G$  the two eminences of water, whose lowest parts are at  $a$  and  $d$ , (fig. 3.), at  $N$  and  $S$ , (fig. 4.), and at  $b$  and  $c$ , (fig. 5.), always 90 degrees from the highest. Now when the moon is in her greatest north declination at  $M$ , the highest elevation  $G$  under her, is on the tropic of Cancer,  $T\text{C}$ , and the opposite elevation  $F$  on the tropic of Capricorn  $tr$ ; and these two elevations describe the tropics

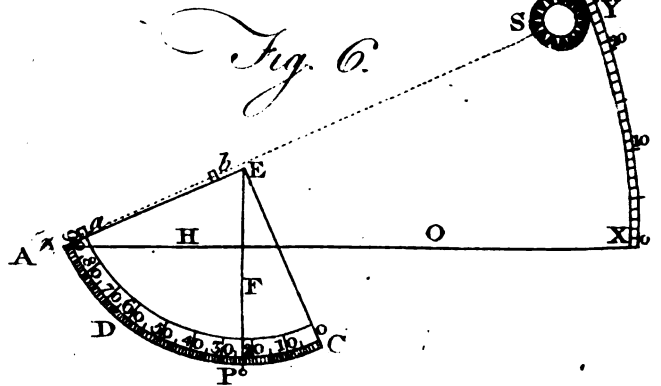




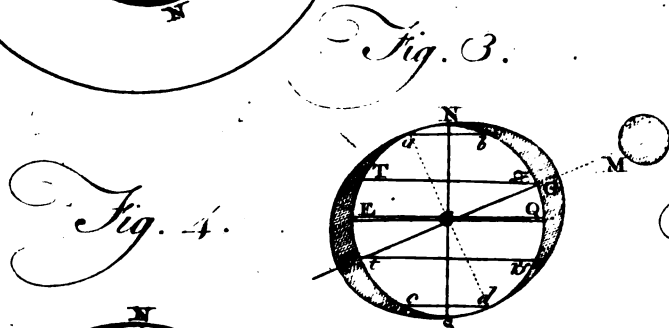
*Fig. 1.*



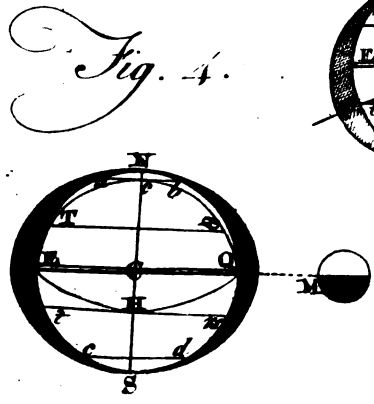
*Fig. 2.*



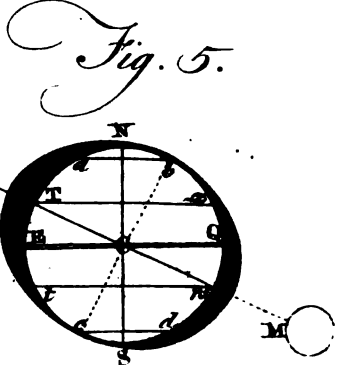
*Fig. 6.*



*Fig. 3.*



*Fig. 4.*



*Fig. 5.*

*A. Bell's Invention!*

pics by the earth's diurnal rotation. All places in the northern hemisphere  $ENQ$  have the highest tides when they come into the position  $bEQ$ , under the moon; and the lowest tides when the earth's diurnal rotation carries them into the position  $aTE$ , on the side opposite to the moon; the reverse happens at the same time in the southern hemisphere  $ESQ$ , as is evident to sight. The axis of the tides  $aCd$  has now its poles  $a$  and  $d$  (being always 90 degrees from the highest elevations) in the arctic and antarctic circles; and therefore it is plain, that at these circles there is but one tide of flood, and one of ebb, in the lunar day. For, when the point  $a$  revolves half round to  $b$ , in 12 lunar hours, it has a tide of flood; but when it comes to the same point  $a$  again in 12 hours more, it has the lowest ebb. In seven days afterward, the moon  $M$  comes to the equinoctial circle, and is over the equator  $EQ$ , when both elevations describe the equator; and in both hemispheres, at equal distances from the equator, the tides are equally high in both parts of the lunar day. The whole phenomena being reversed, when the moon has south declination, to what they were when her declination was north, require no farther description.

In Plate XLV. fig. 3. 4. 5. the earth is orthographically projected on the plane of the meridian; but in order to describe a particular phenomenon, we now project it on the plane of the ecliptic. In the same Plate fig. 2. let  $HZON$  be the earth and sea,  $FED$  the equator,  $T$  the tropic of Cancer,  $C$  the arctic circle,  $P$  the north pole, and the curves 1 2 3, &c. 24 meridians, or hour-circles, intersecting each other in the poles;  $AGM$  is the moon's orbit,  $S$  the Sun,  $M$  the moon,  $Z$  the water elevated under the moon, and  $N$  the opposite equal elevation. As the lowest parts of the water are always 90 degrees from the highest, when the moon is in either of the tropics, (as at  $M$ ), the elevation  $Z$  is on the tropic of Capricorn, and the opposite elevation  $N$  on the tropic of Cancer, the low-water circle  $HCO$  touches the polar circles at  $C$ ; and the high-water circle  $ETP6$  goes over the poles at  $P$ , and divides every parallel of latitude into two equal segments. In this case the tides upon every parallel are alternately higher and lower; but they return in equal times: The point  $T$ , for example, on the tropic of Cancer, (where the depth of the tide is represented by the breadth of the dark shade), has a shallower tide of flood at  $T$  than when it revolves half round from thence to 6, according to the order of the numeral figures; but it revolves as soon from 6 to  $T$  as it did from  $T$  to 6. When the moon is in the equinoctial, the elevations  $Z$  and  $N$  are transferred to the equator at  $O$  and  $H$ , and the high and low-water circles are got into each other's former places; in which case the tides return in unequal times, but are equally high in both parts of the lunar day: for a place at 1 (under  $D$ ) revolving as formerly, goes sooner from 1 to 11, (under  $F$ ), than from 11 to 1, because the parallel it describes is cut into unequal segments by the high-water circle  $HCO$ : but the points 1 and 11 being equidistant from the pole of the tides at  $C$ , which is directly under the pole of the moon's orbit  $MG A$ , the elevations are equally high in both parts of the day.

And thus it appears, that as the tides are governed by the moon, they must turn on the axis of the moon's orbit, which is inclined  $23\frac{1}{2}$  degrees to the earth's axis at a mean state: and therefore the poles of the tides must be so many degrees from the poles of the earth, or in opposite points of the polar circles, going round these circles in every lunar day. It is true, that, according to Plate XLV. fig. 4. when the moon is vertical to the equator  $ECQ$ , the poles of the tides seem to fall in with the poles of the world  $N$  and  $S$ : but when we consider that  $FHC$  is under the moon's orbit, it will appear, that when the moon is over  $H$ , in the tropic of Capricorn, the north pole of the tides (which can be no more than 90 degrees from under the moon) must be at  $c$  in the arctic circle, not at  $N$ , the north pole of the earth; and as the moon ascends from  $H$  to  $G$  in her orbit, the north pole of the tides must shift from  $c$  to  $a$  in the arctic circle, and the south pole as much in the antarctic.

It is not to be doubted, but that the earth's quick rotation brings the poles of the tides nearer to the poles of the world, than they would be if the earth were at rest, and the moon revolved about it only once a month; for otherwise the tides would be more unequal in their heights, and times of their returns, than we find they are. But how near the earth's rotation may bring the poles of its axis and those of the tides together, or how far the preceding tides may affect those which follow, so as to make them keep up nearly to the same heights, and times of ebbing and flowing, is a problem more fit to be solved by observation than by theory.

Those who have opportunity to make observations, and chuse to satisfy themselves whether the tides are really affected in the above manner by the different positions of the moon, especially as to the unequal times of their returns, may take this general rule for knowing when they ought to be so affected. When the earth's axis inclines to the moon, the northern tides, if not retarded in their passage through shoals and channels, nor affected by the winds, ought to be greatest when the moon is above the horizon, least when she is below it, and quite the reverse when the earth's axis declines from her; but, in both cases, at equal intervals of time. When the earth's axis inclines sidewise to the moon, both tides are equally high, but they happen at unequal intervals of time. In every lunation the earth's axis inclines once to the moon, once from her, and twice sidewise to her, as it does to the sun every year; because the moon goes round the ecliptic every month, and the sun but once in a year. In summer, the earth's axis inclines towards the moon when new; and therefore the day-tides in the north ought to be highest, and night-tides lowest about the change; at the full the reverse. At the quarters they ought to be equally high, but unequal in their returns; because the earth's axis then inclines sidewise to the moon. In winter the phenomena are the same at full-moon as in summer at new. In autumn the earth's axis inclines sidewise to the moon when new and full; therefore the tides ought to be equally high, and unequal in their returns at these times. At the first quarter the tides of flood should be least when the moon is above the horizon, greatest when she is below it; and the reverse

at her third quarter. In spring, the phenomena of the first quarter answer to those of the third quarter in autumn; and *vice versa*. The nearer any time is to either of these seasons, the more the tides partake of the phenomena of these seasons; and in the middle between any two of them the tides are at a mean state between those of both.

In open seas, the tides rise but to very small heights in proportion to what they do in wide-mouthed rivers, opening in the direction of the stream of tide. For, in channels growing narrower gradually, the water is accumulated by the opposition of the contracting bank; like a gentle wind, little felt on an open plain, but strong and brisk in a street; especially if the wider end of the street be next the plain, and in the way of the wind.

The tides are so retarded in their passage through different shoals and channels, and otherwise so variously affected by striking against capes and headlands, that to different places they happen at all distances of the moon from the meridian; consequently at all hours of the lunar day. The tide propagated by the moon in the German ocean, when she is three hours past the meridian, takes 12 hours to come from thence to London-Bridge; where it arrives by the time that a new tide is raised in the ocean. And therefore when the moon has north declination, and we should expect the tide at London to be greatest when the moon is above the horizon, we find it is least; and the contrary when she has south declination. At several places it is high water three hours before the moon comes to the meridian; but that tide which the moon pushes as it were before her, is only the tide opposite to that which was raised by her when she was nine hours past the opposite meridian.

There are no tides in lakes, because they are generally so small, that when the moon is vertical she attracts every part of them alike, and therefore, by rendering all the water equally light, no part of it can be raised higher than another. The Mediterranean and Baltic seas suffer very small elevations, because the inlets by which they communicate with the ocean are so narrow, that they cannot, in so short a time, receive or discharge enough to raise or sink their surfaces sensibly.

Air being lighter than water, and the surface of the atmosphere being nearer to the moon than the surface of the sea, it cannot be doubted that the moon raises much higher tides in the air than in the sea. And therefore many have wondered why the mercury does not sink in the barometer when the moon's action on the particles of air makes them lighter as she passes over the meridian. But we must consider, that as these particles are rendered lighter, a greater number of them is accumulated, until the deficiency of gravity be made up by the height of the column; and then there is an *equilibrium*, and consequently an equal pressure upon the mercury as before; so that it cannot be affected by the aerial tides.

#### CHAP. XVI. *Of Eclipses: Their Number and Periods. A large Catalogue of ancient and modern Eclipses.*

EVERY planet and satellite is illuminated by the sun;

and casts a shadow towards that point of the heavens which is opposite to the sun. This shadow is nothing but a privation of light in the space hid from the sun by the opaque body that intercepts his rays.

When the sun's light is so intercepted by the moon, that to any place of the earth the sun appears partly or wholly covered, he is said to *undergo an eclipse*; though, properly speaking, it is only an eclipse of that part of the earth where the moon's shadow or penumbra falls. When the earth comes between the sun and moon, the moon falls into the earth's shadow; and, having no light of her own, she suffers a real eclipse from the interception of the sun's rays. When the sun is eclipsed to us, the moon's inhabitants, on the side next the earth, see her shadow like a dark spot travelling over the earth, about twice as fast as its equatorial parts move, and the same way as they move. When the moon is in an eclipse, the sun appears eclipsed to her, total to all those parts on which the earth's shadow falls, and of as long continuance as they are in the shadow.

That the earth is spherical (for the hills take off no more from the roundness of the earth, than grains of dust do from the roundness of a common globe) is evident from the figure of its shadow on the moon; which is always bounded by a circular line, although the earth is incessantly turning its different sides to the moon, and very seldom shews the same side to her in different eclipses, because they seldom happen at the same hours. Were the earth shaped like a round flat plate, its shadow would only be circular when either of its sides directly faced the moon; and more or less elliptical as the earth happened to be turned more or less obliquely towards the moon when she is eclipsed. The moon's different phases prove her to be round; for, as she keeps still the same side towards the earth, if that side were flat, as it appears to be, she would never be visible from the third quarter to the first; and from the first quarter to the third, she would appear as round as when we say *she is full*; because, at the end of her first quarter, the sun's light would come as suddenly on all her side next the earth, as it does on a flat wall; and go off as abruptly at the end of her third quarter.

If the earth and sun were equally large, the earth's shadow would be infinitely extended, and all of the same bulk; and the planet Mars, in either of its nodes and opposite to the sun, would be eclipsed in the earth's shadow. Were the earth larger than the sun, its shadow would increase in bulk the farther it extended, and would eclipse the great planets Jupiter and Saturn, with all their moons, when they were opposite to the sun. But as Mars, in opposition, never falls into the earth's shadow, although he is not then above 42 millions of miles from the earth, it is plain that the earth is much less than the sun; for otherwise its shadow could not end in a point at so small a distance. If the sun and moon were equally large, the moon's shadow would go on to the earth with an equal breadth, and cover a portion of the earth's surface more than 2000 miles broad, even if it fell directly against the earth's centre, as seen from the moon; and much more if it fell obliquely on the earth: But the moon's shadow is seldom 150 miles broad at the earth, unless when it falls

very



Fig. 1.

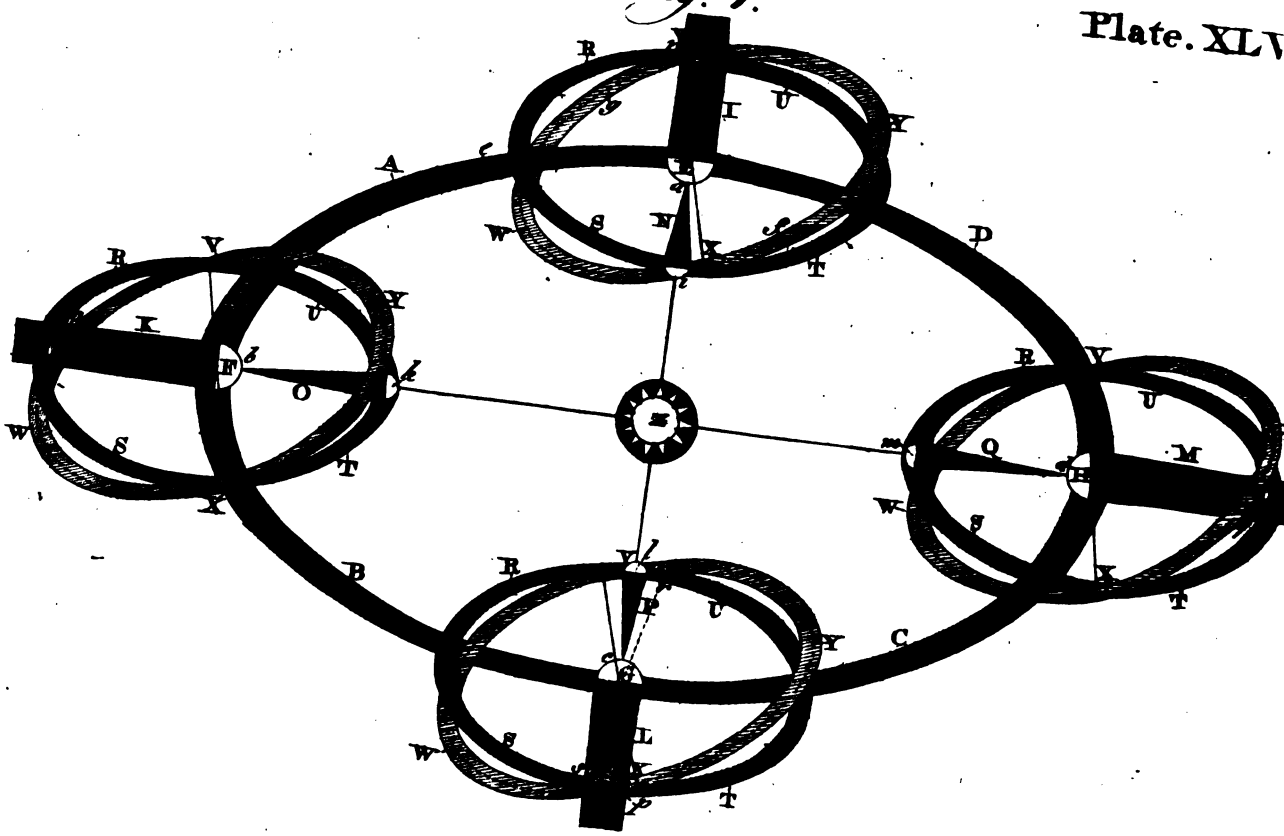


Fig. 2.

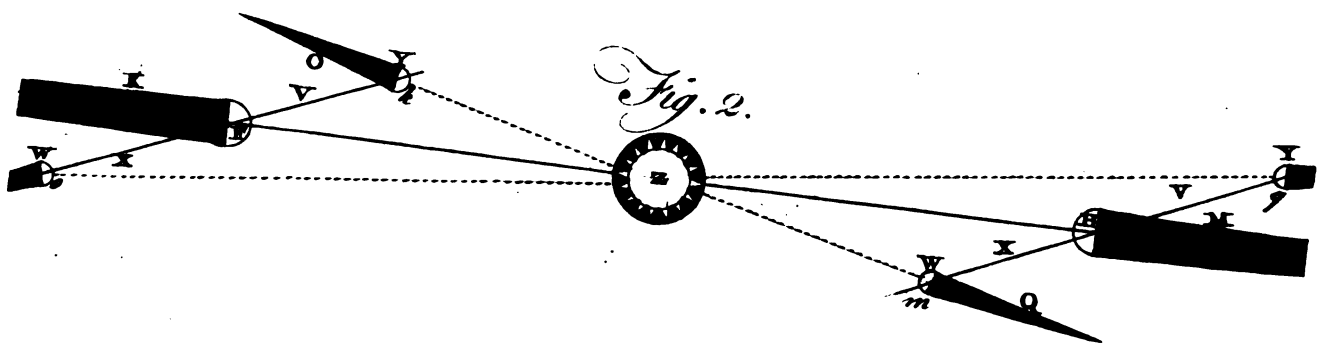
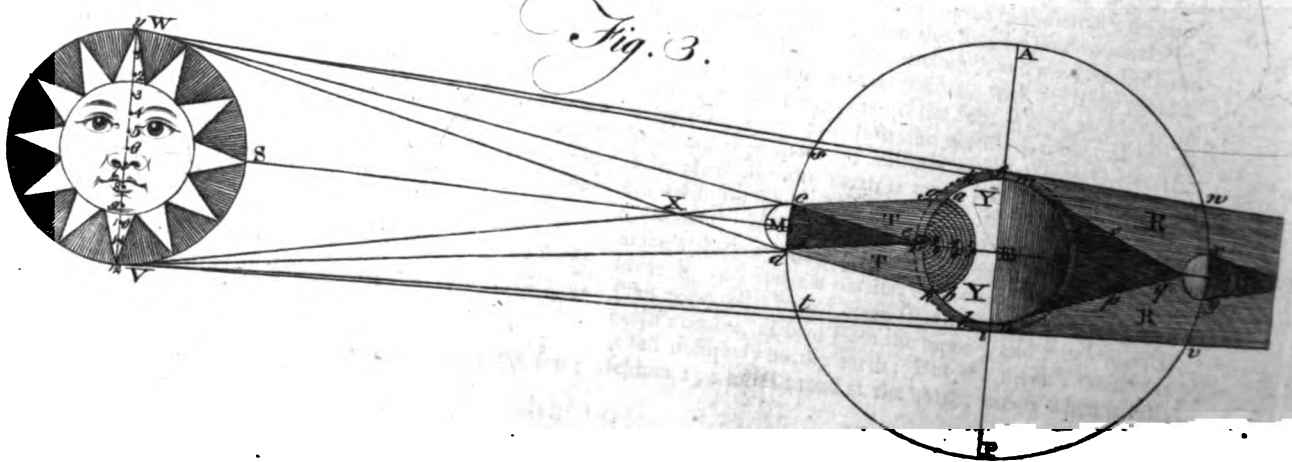


Fig. 3.





very obliquely on the earth, in total eclipses of the sun. In annular eclipses, the moon's real shadow ends in a point at some distance from the earth. The moon's small distance from the earth, and the shortness of her shadow, prove her to be less than the sun. And, as the earth's shadow is large enough to cover the moon, if her diameter were three times as large as it is (which is evident from her long continuance in the shadow when she goes through its centre) it is plain, that the earth is much bigger than the moon.

Though all opaque bodies, on which the sun shines, have their shadows, yet such is the bulk of the sun, and the distances of the planets, that the primary planets can never eclipse one another. A primary can eclipse only its secondary, or be eclipsed by it; and never but when in opposition or conjunction with the sun. The primary planets are very seldom in these positions, but the sun and moon are so every month: Whence one may imagine, that these two luminaries should be eclipsed every month. But there are few eclipses in respect of the number of new and full moons; the reason of which we shall now explain.

If the moon's orbit were coincident with the plane of the ecliptic, in which the earth always moves and the sun appears to move, the moon's shadow would fall upon the earth at every change, and eclipse the sun to some parts of the earth. In like manner, the moon would go through the middle of the earth's shadow, and be eclipsed at every full; but with this difference, that she would be totally darkened for above an hour and an half; whereas the sun never was above four minutes totally eclipsed by the interposition of the moon. But one half of the moon's orbit is elevated  $5\frac{1}{2}$  degrees above the ecliptic, and the other half as much depressed below it; consequently, the moon's orbit intersects the ecliptic in two opposite points called the *moon's nodes*, as has been already taken notice of. When these points are in a right line with the centre of the sun at new or full moon, the sun, moon, and earth, are all in a right line; and if the moon be then new, her shadow falls upon the earth; if full, the earth's shadow falls upon her. When the sun and moon are more than 17 degrees from either of the nodes at the time of conjunction, the moon is then generally too high or too low in her orbit to cast any part of her shadow upon the earth; when the sun is more than 12 deg. from either of the nodes at the time of full moon, the moon is generally too high or too low in her orbit to go thro' any part of the earth's shadow: And in both these cases there will be no eclipse. But when the moon is less than 17 degrees from either node at the time of conjunction, her shadow or penumbra falls more or less upon the earth, as she is more or less within this limit. And when she is less than 12 degrees from either node at the time of opposition, she goes through a greater or less portion of the earth's shadow, as she is more or less within this limit. Her orbit contains 360 degrees; of which 17, the limit of solar eclipses on either side of the nodes, and 12, the limit of lunar eclipses, are but small portions: And as the sun commonly passes by the nodes but twice in a year, it is no wonder that we have so many new and full moons without eclipses.

To illustrate this, (Plate XLVI. fig. 1.) let *ABCD*

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be the ecliptic, *RSTU* a circle lying in the same plane with the ecliptic, and *VWXY* the moon's orbit, all thrown into an oblique view, which gives them an elliptical shape to the eye. One half of the moon's orbit, as *VWX*, is always below the ecliptic, and the other half *X'Y'* above it. The points *V* and *X*, where the moon's orbit intersects the circle *RSTU*, which lies even with the ecliptic, are the moon's nodes; and a right line, as *XEV*, drawn from one to the other, through the earth's centre, is the line of the nodes, which is carried almost parallel to itself round the sun in a year.

If the moon moved round the earth in the orbit *RSTU*, which is coincident with the plane of the ecliptic, her shadow would fall upon the earth every time she is in conjunction with the sun, and at every opposition she would go through the earth's shadow. Were this the case, the sun would be eclipsed at every change, and the moon at every full, as already mentioned.

But although the moon's shadow *N* must fall upon the earth at *a*, when the earth is at *E*, and the moon in conjunction with the sun at *i*, because she is then very near one of her nodes; and at her opposition *n* she must go through the earth's shadow *I*, because she is then near the other node; yet, in the time that she goes round the earth to her next change, according to the order of the letters *X'Y'W*, the earth advances from *E* to *e*, according to the order of the letters *EFGH*, and the line of the nodes *VEX* being carried nearly parallel to itself, brings the point *f* of the moon's orbit in conjunction with the sun at that next change; and then the moon being at *f*, is too high above the ecliptic to cast her shadow on the earth: And as the earth is still moving forward, the moon at her next opposition will be at *g*, too far below the ecliptic to go through any part of the earth's shadow; for by that time the point *g* will be at a considerable distance from the earth as seen from the sun.

When the earth comes to *F*, the moon in conjunction with the sun *Z* is not at *k* in a plane coincident with the ecliptic, but above it at *T* in the highest part of her orbit: and then the point *b* of her shadow *O* goes far above the earth (as in fig. 2. which is an edge view of fig. 1.) The moon, at her next opposition, is not at *o* (fig. 1.) but at *W*, where the earth's shadow goes far above her (as in fig. 2.) In both these cases the line of the nodes *VFX* (fig. 1.) is about 90 degrees from the sun, and both luminaries are as far as possible from the limits of the eclipses.

When the earth has gone half round the ecliptic from *E* to *G*, the line of the nodes *VGX* is nearly, if not exactly, directed towards the sun at *Z*; and then the new-moon *l* casts her shadow *P* on the earth *G*; and the full moon *p* goes through the earth's shadow *L*; which brings on eclipses again, as when the earth was at *E*.

When the earth comes to *H*, the new moon falls not at *m* in a plane coincident with the ecliptic *CD*, but at *W* in her orbit below it; and then her shadow *Q* (see fig. 2.) goes far below the earth. At the next full she is not at *q* (fig. 1.) but at *T* in her orbit  $5\frac{1}{2}$  degrees above *q*, and at her greatest height above the ecliptic *CD*; being then as far as possible, at any opposition, from the earth's shadow *M*, as in fig. 2.

So, when the earth is at *E* and *G*, the moon is about

†

6 E

her

her nodes at new and full; and in her greatest *north* and *south declination* (or latitude, as it is generally called) from the ecliptic at her quarters: But when the earth is at *F* or *H*, the moon is in her greatest *north* and *south declination* from the ecliptic at new and full, and in the *nodes* about her quarters.

The point *X* where the moon's orbit crosses the ecliptic, is called *the ascending node*, because the moon ascends from it above the ecliptic: And the opposite point of intersection *V* is called *the descending node*, because the moon descends from it below the ecliptic. When the moon is at *T* in the highest point of her orbit, she is in her greatest *north latitude*; and when she is at *W* in the lowest point of her orbit, she is in her greatest *south latitude*.

If the line of the nodes, like the earth's axis, was carried parallel to itself round the sun, there would be just half a year between the conjunctions of the sun and nodes. But the nodes shift backward, or contrary to the earth's annual motion,  $19\frac{1}{2}$  deg. every year; and therefore the same node comes round to the sun 19 days sooner every year than on the year before. Consequently, from the time that the ascending node *X* (when the earth is at *E*) passes by the sun as seen from the earth, it is only 173 days (not half a year) till the descending node *V* passes by him. Therefore, in whatever time of the year we have eclipses of the luminaries about either node, we may be sure that in 173 days afterward we shall have eclipses about the other node. And when at any time of the year the line of the nodes is in the situation *VGX*, at the same time next year it will be in the situation *rGs*; the ascending node having gone backward, that is, contrary to the order of signs, from *X* to *s*, and the descending node from *V* to *r*; each  $19\frac{1}{2}$  deg. At this rate the nodes shift through all the signs and degrees of the ecliptic in 18 years and 225 days; in which time there would always be a regular period of eclipses, if any complete number of lunations were finished without a fraction. But this never happens; for if both the sun and moon should start from a line of conjunction with either of the nodes in any point of the ecliptic, the sun would perform 18 annual revolutions and 222 degrees over and above, and the moon 230 lunations and 85 degrees of the 231st, by the time the node came round to the same point of the ecliptic again: So that the sun would then be 138 degrees from the node, and the moon 85 degrees from the sun.

But, in 223 mean lunations, after the sun, moon, and nodes, have been once in a line of conjunction, they return so nearly to the same state again, as that the same node, which was in conjunction with the sun and moon at the beginning of the first of these lunations, will be within  $28' 12''$  of a degree of a line of conjunction with the sun and moon again, when the last of these lunations is completed. And therefore, in that time there will be a regular period of eclipses, or return of the same eclipse, for many ages.—In this period, (which was first discovered by the Chaldeans), there are 18 Julian years 11 days 7 hours 43 minutes 20 seconds, when the last day of February in leap-years is four times included:

But when it is five times included, the period consists of only 18 years 10 days 7 hours 43 minutes 20 seconds. Consequently, if to the mean time of any eclipse, either of the sun or moon, you add 18 Julian years 11 days 7 hours 43 minutes 20 seconds, when the last day of February in leap-years comes in four times, or a day less when it comes in five times, you will have the mean time of the return of the same eclipse.

But the falling back of the line, or conjunctions, or oppositions of the sun and moon  $28' 12''$  with respect to the line of the nodes in every period, will wear it out in process of time; and after that, it will not return again in less than 12492 years.—These eclipses of the sun, which happen about the ascending node, and begin to come in at the north pole of the earth, will go a little southerly at each return, till they go quite off the earth at the south pole; and those which happen about the descending node, and begin to come in at the south pole of the earth, will go a little northerly at each return, till at last they quite leave the earth at the north pole.

To exemplify this matter, we shall first consider the sun's eclipse, (March 21st old style, April 1st new style), A. D. 1764, according to its mean revolutions, without equating the times, or the sun's distance from the node; and then according to its true equated times.

This eclipse fell in open space at each return, quite clear of the earth, even since the creation, till A. D. 1295, June 13th old style, at 12 h. 52 m. 59 sec. *post meridiem*, when the moon's shadow first touched the earth at the north pole; the sun being then  $17^{\circ} 48' 27''$  from the ascending node.—In each period since that time, the sun has come  $28' 12''$  nearer and nearer the same node, and the moon's shadow has therefore gone more and more southerly.—In the year 1962, July 18th old style, at 10 h. 36 m. 21 sec. *p. m.* when the same eclipse will have returned 38 times, the sun will be only  $24' 45''$  from the ascending node, and the centre of the moon's shadow will fall a little northward of the earth's centre.—At the end of the next following period, A. D. 1980, July 28th old style, at 18 h. 19 m. 41 sec. *p. m.* the sun will have receded back  $3' 27''$  from the ascending node, and the moon will have a very small degree of southern latitude, which will cause the centre of her shadow to pass a very small matter south of the earth's centre.—After which, in every following period, the sun will be  $28' 12''$  farther back from the ascending node than in the period last before; and the moon's shadow will go still farther and farther southward, until September 12th old style, at 23 h. 46 m. 22 sec. *p. m.* A. D. 2665; when the eclipse will have completed its 77th periodical return, and will go quite off the earth at the south pole (the sun being then  $17^{\circ} 55' 22''$  back from the node) and cannot come in at the north pole, so as to begin the same course over again, in less than 12492 years afterward.—And such will be the case of every other eclipse of the sun: For, as there is about 18 degrees on each side of the node within which there is a possibility of eclipses, their whole revolution goes through 36 degrees about that node, which, taken from 360 degrees, leaves remaining 324 degrees for the eclipses to travel in *expansum*

*expansum*. And as this 36 degrees is not gone through in less than 77 periods, which takes up 1388 years, the remaining 324 degrees cannot be so gone through in less than 12492 years. For, as 36 is to 1388, so is 324 to 12492.

To illustrate this a little farther, we shall examine some of the most remarkable circumstances of the returns of the eclipse which happened July 14th 1748, about noon. This eclipse, after traversing the voids of space from the creation, at last began to enter the Terra Australis Incognita about 88 years after the conquest, which was the last of king Stephen's reign; every Chaldean period it has crept more northerly, but was still invisible in Britain before the year 1622; when, on the 30th of April, it began to touch the south parts of England about 2 in the afternoon; its central appearance rising in the American south seas, and traversing Peru and the Amazon's country, through the Atlantic ocean into Africa, and setting in the Ethiopian continent, not far from the beginning of the Red sea.

Its next visible period was after three Chaldean revolutions in 1676, on the first of June, rising central in the Atlantic ocean, passing us about 9 in the morning, with four digits eclipsed on the under limb, and setting in the gulf of CochinChina in the East Indies.

It being now near the solstice, this eclipse was visible the very next return in 1694, in the evening; and in two periods more, which was in 1730, on the 4th of July, was seen about half eclipsed just after sun-rise, and observed both at Wirtemberg in Germany, and Pekin in China, soon after which it went off.

Eighteen years more afforded us the eclipse which fell on the 14th of July 1748.

The next visible return happened on July 25th 1766, in the evening, about four digits eclipsed; and after two periods more, will happen on August 16th 1802, early in the morning, about five digits, the centre coming from the north frozen continent, by the capes of Norway, through Tartary, China and Japan, to the Ladrone islands, where it goes off.

Again, in 1820, August 26th, between one and two, there will be another great eclipse at London, about 10 digits; but, happening so near the equinox, the centre will leave every part of Britain to the west, and enter Germany at Emden, passing by Venice, Naples, Grand Cairo, and set in the gulf of Bassora near that city.

It will be no more visible till 1874, when five digits will be obscured (the centre being now about to leave the earth) on September 28th. In 1892, the sun will go down eclipsed in London; and again, in 1928, the passage of the centre will be in the *expansum*, though there will be two digits eclipsed at London, October the 31st of that year, and about the year 2090 the whole penumbra will be wore off; whence no more returns of this eclipse can happen till after a revolution of 10 thousand years.

From these remarks on the entire revolution of this eclipse, we may gather, that a thousand years, more or less, (for there are some irregularities that may protract or lengthen this period 100 years), complete the whole terrestrial phenomena of any single eclipse: and since 20 periods of 54 years each, and about 33 days, comprehend the entire extent of their revolution, it is evident, that the times of the returns will pass through a circuit of one year and ten months, every Chaldean period being ten or eleven days later, and of the equable appearances, about 32 or 33 days. Thus, though this eclipse happens about the middle of July, no other subsequent eclipse of this period will return till the middle of the same month again; but wear constantly each period 10 or 11 days forward, and at last appear in winter, but then it begins to cease from affecting us.

Another conclusion from this revolution may be drawn, that there will seldom be any more than two great eclipses of the sun in the interval of this period, and these follow sometimes next return, and often at greater distances. That of 1715 returned again in 1733 very great; but this present eclipse will not be great till the arrival of 1820, which is a revolution of four Chaldean periods; so that the irregularities of their circuits must undergo new computations to assign them exactly.

Nor do all eclipses come in at the south pole: That depends altogether on the position of the lunar nodes, which will bring in as many from the *expansum* one way as the other; and such eclipses will wear more southerly by degrees, contrary to what happens in the present case.

The eclipse, for example, of 1736 in September, had its centre in the *expansum*, and set about the middle of its obscurity in Britain; it will wear in at the north pole, and in the year 2600, or thereabouts, go off into the *expansum* on the south side of the earth.

The eclipses therefore which happened about the creation are little more than half way yet of their ethereal circuit; and will be 4000 years before they enter the earth any more. This grand revolution seems to have been intirely unknown to the ancients.

It is particularly to be noted, that eclipses which have happened many centuries ago, will not be found by our present tables to agree exactly with ancient observations, by reason of the great anomalies in the lunar motions; which appears an incontestable demonstration of the non-eternity of the universe. For it seems confirmed by undeniable proofs, that the moon now finishes her period in less time than formerly, and will continue, by the centripetal law, to approach nearer and nearer the earth, and to go sooner and sooner round it: Nor will the centrifugal power be sufficient to compensate the different gravitations of such an assemblage of bodies as constitute the solar system, which would come to ruin of itself, without some new regulation and adjustment of their original motions \*.

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\* There are two ancient eclipses of the moon, recorded by Ptolemy from Hipparchus, which afford an undeniable proof of the moon's acceleration. The first of these was observed at Babylon, Decem. 22d, in the year before Christ 383; when the moon began to be eclipsed, about half an hour before the sun rose, and the eclipse was not

We are credibly informed from the testimony of the ancients, that there was a total eclipse of the sun predicted by Thales to happen in the fourth year of the 48th Olympiad, either at Sardis or Miletus in Asia, where Thales then resided. That year corresponds to the 585th year before Christ; when accordingly there happened a very signal eclipse of the sun, on the 28th of May, answering to the present 10th of that month, central through North America, the south parts of France, Italy, &c. as far as Athens, or the isles in the Ægean sea; which is the farthest that even the Caroline tables carry it; and consequently make it invisible to any part of Asia, in the total character; though there are good reasons to believe that it extended to Babylon, and went down central over that city. We are not however to imagine, that it was set before it past Sardis and the Asiatic towns, where the predictor lived; because an invisible eclipse could have been of no service to demonstrate his ability in astronomical sciences to his countrymen, as it could give no proof of its reality.

For a farther illustration, Thucydides relates, That a solar eclipse happened on a summer's day in the afternoon, in the first year of the Peloponnesian war, so great, that the stars appeared. Rhodius was victor in the Olympic games the fourth year of the said war, being also the fourth of the 87th Olympiad, on the 428th year before Christ. So that the eclipse must have happened in the 431st year before Christ; and by computation it appears, that on the third of August there was a signal eclipse which would have past over Athens, central about 6 in the evening, but which our present tables bring no farther than the ancient Syrtis on the African coast, above 400 miles from Athens; which suffering in that case but 9 digits, could by no means exhibit the remarkable darkness recited by this historian; the centre therefore seems to have past Athens about 6 in the evening, and probably might go down about Jerusalem, or near it, contrary to the construction of the present tables. These things are only obviated by way of caution to the present astronomers, in re-computing ancient eclipses; and they may examine the eclipse of Nicias, so fatal to the Athenian fleet; that which overthrew the Macedonian army, &c.

In any year, the number of eclipses of both luminaries cannot be less than two, nor more than seven; the most usual number is four, and it is very rare to have more

than six. For the sun passes by both the nodes but once a-year, unless he passes by one of them in the beginning of the year; and if he does, he will pass by the same node again a little before the year be finished; because, as these points move  $19\frac{1}{2}$  degrees backward every year, the sun will come to either of them 173 days after the other. And when either node is within 17 degrees of the sun at the time of new moon, the sun will be eclipsed. At the subsequent opposition, the moon will be eclipsed in the other node, and come round to the next conjunction again ere the former node be 17 degrees past the sun, and will therefore eclipse him again. When three eclipses fall about either node, the like number generally falls about the opposite; as the sun comes to it in 173 days afterward; and six lunations contain but four days more. Thus, there may be two eclipses of the sun, and one of the moon, about each of her nodes. But when the moon changes in either of the nodes, she cannot be near enough the other node at the next full to be eclipsed; and in six lunar months afterward she will change near the other node: in these cases there can be but two eclipses in a year, and they are both of the sun.

A longer period than the above mentioned, for comparing and examining eclipses which happen at long intervals of time, is 557 years, 21 days, 18 hours, 30 minutes, 11 seconds; in which time there are 6890 mean lunations; and the sun and node meet again so nearly as to be but 11 seconds distant; but then it is not the same eclipse that returns, as in the shorter period above mentioned.

*A List of Eclipses, and historical Events, which happened about the same times, from*  
RICCIOLUS.

Before CHRIST.

754	July	5	But, according to an old calendar, this eclipse of the sun was on the 21st of April, on which day the foundations of Rome were laid; if we may believe Taruntius Firmanus.
721	March	19	A total eclipse of the moon. The Assyrian empire at an end; the Babylonian established.

*not over before the moon set: But, by most of our astronomical tables, the moon was set at Babylon half an hour before the eclipse began; in which case, there could have been no possibility of observing it. The second eclipse was observed at Alexandria, Septem. 22d, the year before Christ 201; where the moon rose so much eclipsed, that the eclipse must have begun about half an hour before she rose: Whereas, by most of our tables, the beginning of this eclipse was not till about 10 minutes after the moon rose at Alexandria. Had these eclipses begun and ended while the sun was below the horizon, we might have imagined, that as the ancients had no certain way of measuring time, they might have been so far mistaken in the hours, that we could not have laid any stress on the accounts given by them. But as, in the first eclipse, the moon was set, and consequently the sun risen, before it was over; and in the second eclipse the sun was set, and the moon not risen, till some time after it began; these are such circumstances as the observers could not possibly be mistaken in. Mr Struyk, in the following catalogue, notwithstanding the express words of Ptolemy, puts down these two eclipses as observed at Athens; where they might have been seen as above, without any acceleration of the moon's motion, Athens being 20 degrees west of Babylon, and 7 degrees west of Alexandria.*

AN

Before Christ.			
585	May	28	An eclipse of the sun foretold by Thales, by which a peace was brought about between the Medes and Lydians.
523	July	16	An eclipse of the moon, which was followed by the death of Cambyfes.
502	Nov.	19	An eclipse of the moon, which was followed by the slaughter of the Sabines, and death of Valerius Publicola.
463	April	30	An eclipse of the sun. The Persian war, and the falling off of the Persians from the Egyptians.
431	April	25	An eclipse of the moon, which was followed by a great famine at Rome; and the beginning of the Peloponnesian war.
431	August	3	A total eclipse of the sun. A comet and plague at Athens.
413	August	27	A total eclipse of the moon. Nicias with his ship destroyed at Syracuse.
394	August	14	An eclipse of the sun. The Persians beat by Conon in a sea-engagement.
168	June	21	A total eclipse of the moon. The next day Perseus, king of Macedonia, was conquered by Paulus Emilius.
After Christ.			
59	April	30	An eclipse of the sun. This is reckoned among the prodigies, on account of the murder of Agrippinus by Nero.
237	April	12	A total eclipse of the sun. A sign that the reign of the Gordiani would not continue long. A sixth persecution of the Christians.
306	July	27	An eclipse of the sun. The stars were seen, and the emperor Constantius died.
840	May	4	A dreadful eclipse of the sun. And Lewis the Pious died within six months after it.
1009			An eclipse of the sun. And Jerusalem taken by the Saracens.
1133	August	2	A terrible eclipse of the sun. The stars were seen. A schism in the church, occasioned by there being three Popes at once.

because the sun's ecliptic limits are greater than the moon's; yet we have more visible eclipses of the moon than of the sun, because eclipses of the moon are seen from all parts of that hemisphere of the earth which is next her, and are equally great to each of those parts; but the sun's eclipses are visible only to that small portion of the hemisphere next him whereon the moon's shadow falls.

The moon's orbit being elliptical, and the earth in one of its focuses, she is once at her least distance from the earth, and once at her greatest, in every lunation. When the moon changes at her least distance from the earth, and so near the node that her dark shadow falls upon the earth, she appears big enough to cover the whole disk of the sun from that part on which her shadow falls; and the sun appears totally eclipsed there for some minutes: but when the moon changes at her greatest distance from the earth, and so near the node that her dark shadow is directed towards the earth, her diameter subtends a less angle than the sun's; and therefore she cannot hide his whole disk from any part of the earth, nor does her shadow reach it at that time; and to the place over which the point of her shadow hangs, the eclipse is annular, the sun's edge appearing like a luminous ring all around the body of the moon. When the change happens within 17 degrees of the node, and the moon at her mean distance from the earth, the point of her shadow just touches the earth, and she eclipseth the sun totally to that small spot whereon her shadow falls; but the darkness is not of a moment's continuance.

The moon's apparent diameter, when largest, exceeds the sun's, when least, only 1 minute 38 seconds of a degree; and in the greatest eclipse of the sun that can happen at any time and place, the total darkness continues no longer than whilst the moon is going 1 minute 38 seconds from the sun in her orbit, which is about 3 minutes and 13 seconds of an hour.

The moon's dark shadow covers only a spot on the earth's surface, about 180 English miles broad, when the moon's diameter appears largest, and the sun's least; and the total darkness can extend no farther than the dark shadow covers. Yet the moon's partial shadow or penumbra may then cover a circular space 4900 miles in diameter, within all which the sun is more or less eclipsed, as the places are less or more distant from the centre of the penumbra. When the moon changes exactly in the node, the penumbra is circular on the earth at the middle of the general eclipse; because at that time it falls perpendicularly on the earth's surface; but at every other moment it falls obliquely, and will therefore be elliptical; and the more so, as the time is longer before or after the middle of the general eclipse; and then, much greater portions of the earth's surface are involved in the penumbra.

When the penumbra first touches the earth, the general eclipse begins; when it leaves the earth, the general eclipse ends: from the beginning to the end the sun appears eclipsed in some part of the earth or other. When the penumbra touches any place, the eclipse begins at that place, and ends when the penumbra leaves it. When the moon changes in the node, the penumbra

We have not enumerated one half of Ricciolus's list of portentous eclipses; and for the same reason that he declines giving any more of them than what that list contains, namely, that it is most disagreeable to dwell any longer on such nonsense: the superstition of the ancients may be seen by the few here copied.

Eclipses of the sun are more frequent than of the moon,  
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goes over the centre of the earth's disk as seen from the moon; and consequently, by describing the longest line possible on the earth, continues the longest upon it; namely, at a mean rate,  $\frac{1}{2}$  hours 50 minutes; more, if the moon be at her greatest distance from the earth, because she then moves slowest; less, if she be at her least distance, because of her quicker motion.

To make several of the above and other phenomena plainer, (Plate XLVI. fig. 3.), let  $S$  be the sun,  $E$  the earth,  $M$  the moon, and  $AMP$  the moon's orbit. Draw the right line  $Wc$  12 from the western side of the sun at  $W$ , touching the western side of the moon at  $c$ , and the earth at 12: draw also the right line  $Vd$  12 from the eastern side of the sun at  $V$ , touching the eastern side of the moon at  $d$ , and the earth at 12: the dark space  $cc12d$  included between those lines is the moon's shadow, ending in a point at 12, where it touches the earth; because in this case the moon is supposed to change at  $M$  in the middle between  $A$  the apogee, or farthest point of her orbit from the earth, and  $P$  the perigee, or nearest point to it. For, had the point  $P$  been at  $M$ , the moon had been nearer the earth; and her dark shadow at  $e$  would have covered a space upon it about 180 miles broad, and the sun would have been totally darkened, with some continuance: but had the point  $A$  been at  $M$ , the moon would have been farther from the earth, and her shadow would have ended in a point about  $e$ , and therefore the sun would have appeared like a luminous ring all around the moon. Draw the right lines  $WXdb$  and  $VXcg$ , touching the contrary sides of the sun and moon, and ending on the earth at  $a$  and  $b$ : draw also the right line  $SXM$  12, from the centre of the sun's disk, through the moon's centre, to the earth at 12; and suppose the two former lines  $WXdb$  and  $VXcg$  to revolve on the line  $SXM$  12 as an axis, and their points  $a$  and  $b$  will describe the limits of the penumbra  $TT$  on the earth's surface, including the large space  $acb12a$ ; within which the sun appears more or less eclipsed, as the places are more or less distant from the verge of the penumbra  $acb$ .

Draw the right line  $y12$  across the sun's disk, perpendicular to  $SXM$  the axis of the penumbra: then divide the line  $y12$  into twelve equal parts, as in the figure, for the twelve digits or equal parts of the sun's diameter; and, at equal distances from the centre of the penumbra at 12 (on the earth's surface  $YY$ ) to its edge  $acb$ , draw twelve concentric circles, as marked with the numeral figures 1 2 3 4 &c. and remember that the moon's motion in her orbit  $AMP$  is from west to east, as from  $s$  to  $t$ . Then,

To an observer on the earth at  $b$ , the eastern limb of the moon at  $d$  seems to touch the western limb of the sun at  $W$ , when the moon is at  $M$ ; and the sun's eclipse begins at  $b$ , appearing as at  $A$  in Plate XLVII. fig. 1. at the left hand; but, at the same moment of absolute time to an observer at  $a$  in Plate XLVI. fig. 3. the western edge of the moon at  $c$  leaves the eastern edge of the sun at  $V$ , and the eclipse ends, as at the right hand  $C$ , Plate XLVII. fig. 1. At the very same instant, to all those who live on the circle marked 1 on the earth  $E$ , in Plate XLVI. fig. 3. the moon  $M$  cuts off or darkens a twelfth part of the sun  $S$ , and eclipses him one digit, as at 1 in

Plate XLVII. fig. 1.: to those who live on the circle marked 2 in Plate XLVI. fig. 3. the moon cuts off two twelfth parts of the sun, as at 2 in Plate XLVII. fig. 1.; to those on the circle 3, three parts; and so on to the centre at 12 in Plate XLVI. fig. 3. where the sun is centrally eclipsed, as at  $B$  in the middle of fig. 1. Plate XLVII.; under which figure there is a scale of hours and minutes, to shew at a mean state how long it is from the beginning to the end of a central eclipse of the sun on the parallel of London; and how many digits are eclipsed at any particular time from the beginning at  $A$  to the middle at  $B$ , or the end at  $C$ . Thus, in 16 minutes from the beginning, the sun is two digits eclipsed; in an hour and five minutes, eight digits; and in an hour and 37 minutes, 12 digits.

By Plate XLVI. fig. 3. it is plain, that the sun is totally or centrally eclipsed but to a small part of the earth at any time; because the dark conical shadow  $e$  of the moon  $M$  falls but on a small part of the earth; and that the partial eclipse is confined at that time to the space included by the circle  $acb$ , of which only one half can be projected in the figure, the other half being supposed to be hid by the convexity of the earth  $E$ : and likewise, that no part of the sun is eclipsed to the large space  $YY$  of the earth, because the moon is not between the sun and any of that part of the earth: and therefore to all that part the eclipse is invisible. The earth turns eastward on its axis, as from  $g$  to  $h$ , which is the same way that the moon's shadow moves; but the moon's motion is much swifter in her orbit from  $s$  to  $t$ : and therefore, although eclipses of the sun are of longer duration on account of the earth's motion on its axis than they would be if that motion was stopt, yet, in four minutes of time at most, the moon's swifter motion carries her dark shadow quite over any place that its centre touches at the time of greatest obscuration. The motion of the shadow on the earth's disk is equal to the moon's motion from the sun, which is about  $30\frac{1}{2}$  minutes of a degree every hour at a mean rate; but so much of the moon's orbit is equal to  $30\frac{1}{2}$  degrees of a great circle on the earth; and therefore the moon's shadow goes  $30\frac{1}{2}$  degrees, or 1830 geographical miles on the earth in an hour, or  $30\frac{1}{2}$  miles in a minute, which is almost four times as swift as the motion of a cannon-ball.

As seen from the sun or moon, the earth's axis appears differently inclined every day of the year, on account of keeping its parallelism throughout its annual course. In Plate XLVII. fig. 2. let  $EDON$  be the earth at the two equinoxes and the two solstices,  $NS$  its axis,  $N$  the north pole,  $S$  the south pole,  $EQ$  the equator,  $T$  the tropic of Cancer,  $t$  the tropic of Capricorn, and  $ABC$  the circumference of the earth's enlightened disk as seen from the sun or new moon at these times. The earth's axis has the position  $NES$  at the vernal equinox, lying towards the right hand, as seen from the sun or new moon; its poles  $N$  and  $S$  being then in the circumference of the disk; and the equator and all its parallels seem to be straight lines, because their planes pass through the observer's eye looking down upon the earth from the sun or moon directly over  $E$ , where the ecliptic  $FG$  intersects the equator  $EQ$ . At the summer solstice, the earth's axis has the position  $NDS$ ; and

and that part of the ecliptic  $FG$ , in which the moon is then new, touches the tropic of Cancer  $T$  at  $D$ . The north pole  $N$  at that time inclining  $23\frac{1}{2}$  degrees towards the sun, falls so many degrees within the earth's enlightened disk, because the sun is then vertical to  $D$ ,  $23\frac{1}{2}$  degrees north of the equator  $\mathcal{EQ}$ ; and the equator with all its parallels seem elliptic curves bending downward, or towards the south pole, as seen from the sun; which pole, together with  $23\frac{1}{2}$  degrees all round it, is hid behind the disk in the dark hemisphere of the earth. At the autumnal equinox, the earth's axis has the position  $NOS$ , lying to the left hand as seen from the sun or new moon, which are then vertical to  $O$ , where the ecliptic cuts the equator  $\mathcal{EQ}$ . Both poles now lie in the circumference of the disk, the north pole just going to disappear behind it, and the south pole just entering into it; and the equator, with all its parallels, seem to be straight lines, because their planes pass through the observer's eye, as seen from the sun, and very nearly so as seen from the moon. At the winter solstice, the earth's axis has the position  $NVS$ ; when its south pole  $S$  inclining  $23\frac{1}{2}$  degrees toward the sun, falls  $23\frac{1}{2}$  degrees within the enlightened disk, as seen from the sun or new moon, which are then vertical to the tropic of Capricorn  $t$ ,  $23\frac{1}{2}$  degrees south of the equator  $\mathcal{EQ}$ ; and the equator, with all its parallels, seem elliptic curves bending upward; the north pole being as far hid behind the disk in the dark hemisphere, as the south pole is come into the light. The nearer that any time of the year is to the equinoxes or solstices, the more it partakes of the phenomena relating to them.

Thus it appears, that from the vernal equinox to the autumnal, the north pole is enlightened; and the equator, and all its parallels, appear elliptical as seen from the sun, more or less curved as the time is nearer to, or farther from, the summer solstice; and bending downwards, or towards the south pole; the reverse of which happens from the autumnal equinox to the vernal. A little consideration will be sufficient to convince the reader, that the earth's axis inclines towards the sun at the summer solstice; from the sun at the winter solstice; and sidewise to the sun at the equinoxes; but towards the right hand, as seen from the sun at the vernal equinox; and towards the left hand at the autumnal. From the winter to the summer solstice, the earth's axis inclines more or less to the right hand, as seen from the sun; and the contrary from the summer to the winter solstice.

The different positions of the earth's axis, as seen from the sun at different times of the year, affect solar eclipses greatly with regard to particular places; yea, so far as would make central eclipses which fall at one time of the year invisible if they fell at another, even though the moon should always change in the nodes, and, at the same hour of the day; of which indefinitely various affections, we shall only give examples for the times of the equinoxes and solstices.

In the same diagram, (Plate XLVII. fig. 2.), let  $FG$  be part of the ecliptic, and  $IK$ ,  $ik$ ,  $ik$ , part of the moon's orbit; both seen edgewise, and therefore projected into right lines; and let the intersections  $NODE$

be one and the same node at the above times, when the earth has the forementioned different positions; and let the spaces included by the circles  $Pppp$  be the penumbra at these times, as its centre is passing over the centre of the earth's disk. At the winter solstice, when the earth's axis has the position  $NVS$ , the centre of the penumbra  $P$  touches the tropic of Capricorn  $t$  in  $N$  at the middle of the general eclipse; but no part of the penumbra touches the tropic of Cancer  $T$ . At the summer solstice, when the earth's axis has the position  $NDS$  ( $iDk$  being then part of the moon's orbit, whose node is at  $D$ ) the penumbra  $p$  has its centre at  $D$ , on the tropic of Cancer  $T$ , at the middle of the general eclipse, and then no part of it touches the tropic of Capricorn  $t$ . At the autumnal equinox, the earth's axis has the position  $NOS$ , ( $iOk$  being then part of the moon's orbit), and the penumbra equally includes part of both tropics  $T$  and  $t$  at the middle of the general eclipse: at the vernal equinox it does the same, because the earth's axis has the position  $NES$ ; but, in the former of these two last cases, the penumbra enters the earth at  $A$ , north of the tropic of Cancer  $T$ , and leaves it at  $m$ , south of the tropic of Capricorn  $t$ ; having gone over the earth obliquely southward, as its centre described the line  $AOm$ : whereas, in the latter case, the penumbra touches the earth at  $n$ , south of the equator  $\mathcal{EQ}$ , and describing the line  $nEq$ , (similar to the former line  $AOm$  in open space), goes obliquely northward over the earth, and leaves it at  $q$ , north of the equator.

In all these circumstances, the moon has been supposed to change at noon in her descending node: Had she changed in her ascending node, the phenomena would have been as various the contrary way, with respect to the penumbra's going northward or southward over the earth. But because the moon changes at all hours, as often in one node as in the other, and at all distances from them both at different times as it happens, the variety of the phases of eclipses are almost innumerable, even at the same places; considering also how variously the same places are situated on the enlightened disk of the earth, with respect to the penumbra's motion, at the different hours when eclipses happen.

When the moon changes 17 degrees short of her descending node, the penumbra  $P$  18 just touches the northern part of the earth's disk, near the north pole  $N$ ; and, as seen from that place, the moon appears to touch the sun, but hides no part of him from sight. Had the change been as far short of the ascending node, the penumbra would have touched the southern part of the disk near the south pole  $S$ . When the moon changes 12 degrees short of the descending node, more than a third part of the penumbra  $P$  12 falls on the northern parts of the earth at the middle of the general eclipse: Had she changed as far past the same node, as much of the other side of the penumbra about  $P$  would have fallen on the southern part of the earth; all the rest in the *expansum*, or open space. When the moon changes 6 degrees from the node, almost the whole penumbra  $P$  6 falls on the earth at the middle of the general eclipse. And lastly, when the moon changes in the node at  $N$ , the penumbra  $P$   $N$  takes the longest course possible on the earth's disk; its centre

centre falling on the middle thereof, at the middle of the general eclipse. The farther the moon changes from either node, within 17 degrees of it, the shorter is the penumbra's continuance on the earth, because it goes over a less portion of the disk, as is evident by the figure.

The nearer that the penumbra's centre is to the equator at the middle of the general eclipse, the longer is the duration of the eclipse at all those places where it is central; because, the nearer that any place is to the equator, the greater is the circle it describes by the earth's motion on its axis: And so, the place moving quicker, keeps longer in the penumbra, whose motion is the same way with that of the place, though faster, as has been already mentioned. Thus (see the earth at *D* and the penumbra at 12) whilst the point *b* in the polar circle *abcd* is carried from *b* to *c* by the earth's diurnal motion, the point *d* on the tropic of Cancer *T* is carried a much greater length from *d* to *D*; and therefore, if the penumbra's centre goes one time over *c* and another time over *D*, the penumbra will be longer in passing over the moving place *d* than it was in passing over the moving place *b*. Consequently, central eclipses about the poles are of the shortest duration; and about the equator of the longest.

In the middle of summer, the whole frigid zone, included by the polar circle *abcd*, is enlightened; and if it then happens, that the penumbra's centre goes over the north pole, the sun will be eclipsed much the same number of digits at *a* as at *c*; but whilst the penumbra moves eastward over *c*, it moves westward over *a*; because, with respect to the penumbra, the motions of *a* and *c* are contrary: For *c* moves the same way with the penumbra towards *d*, but *a* moves the contrary way towards *b*; and therefore the eclipse will be of longer duration at *c* than at *a*. At *a* the eclipse begins on the sun's eastern limb, but at *c* on his western: At all places lying without the polar circles, the sun's eclipses begin on his western limb, or near it, and end on or near his eastern. At those places where the penumbra touches the earth, the eclipse begins with the rising sun, on the top of his western or uppermost edge; and at those places where the penumbra leaves the earth, the eclipse ends with the setting sun, on the top of his eastern edge, which is then the uppermost, just at its disappearing in the horizon.

If the moon were surrounded by an atmosphere of any considerable density, it would seem to touch the sun a little before the moon made her appulse to his edge, and we should see a little faintness on that edge before it were eclipsed by the moon: But as no such faintness has been observed, it seems plain, that the moon has no such atmosphere as that of the earth. The faint ring of light surrounding the sun in total eclipses, called by Cassini *la chevelure du soleil*, seems to be the atmosphere of the sun; because it has been observed to move equally with the sun, not with the moon.

Having been so prolix concerning eclipses of the sun, we shall drop that subject at present, and proceed to the doctrine of lunar eclipses; which, being more simple, may be explained in less time.

That the moon can never be eclipsed but at the time

of her being full, and the reason why she is not eclipsed at every full, has been shewn already. In Plate XLVI. fig. 3. let *S* be the sun, *E* the earth, *RR* the earth's shadow, and *B* the moon in opposition to the sun: In this situation the earth intercepts the sun's light in its way to the moon; and when the moon touches the earth's shadow at *v*, she begins to be eclipsed on her eastern limb *x*, and continues eclipsed until her western limb *y* leaves the shadow at *w*: At *B* she is in the middle of the shadow, and consequently in the middle of the eclipse.

The moon, when totally eclipsed, is not invisible if she be above the horizon and the sky be clear; but appears generally of a dusky colour, like tarnished copper, which some have thought to be the moon's native light. But the true cause of her being visible is the scattered beams of the sun, bent, into the earth's shadow by going through the atmosphere; which, being more or less dense near the earth than at considerable heights above it, refracts or bends the sun's rays more inward, the nearer they are passing by the earth's surface, than those rays which go through higher parts of the atmosphere, where it is less dense according to its height, until it be so thin or rare as to lose its refractive power. Let the circle *sgbi*, concentric to the earth, include the atmosphere whose refractive power vanishes at the heights *f* and *i*; so that the rays *Wfw* and *Viv* go on straight without suffering the least refraction: But all those rays which enter the atmosphere between *f* and *k*, and between *i* and *l*, on opposite sides of the earth, are gradually more bent inward as they go through a greater portion of the atmosphere, until the rays *Wk* and *Vi* touching the earth at *m* and *n*, are bent so much as to meet at *g*, a little short of the moon; and therefore the dark shadow of the earth is contained in the space *mognp*, where none of the sun's rays can enter: All the rest *RR*, being mixed by the scattered rays which are refracted as above, is in some measure enlightened by them; and some of those rays falling on the moon, give her the colour of tarnished copper, or of iron almost red hot. So that if the earth had no atmosphere, the moon would be as invisible in total eclipses as she is when new. If the moon were so near the earth as to go into its dark shadow, suppose about *po*, she would be invisible during her stay in it; but visible before and after in the fainter shadow *RR*.

When the moon goes through the centre of the earth's shadow, she is directly opposite to the sun: Yet the moon has been often seen totally eclipsed in the horizon when the sun was also visible in the opposite part of it: For, the horizontal refraction being almost 34 minutes of a degree, and the diameter of the sun and moon being each at a mean state but 32 minutes, the refraction causes both luminaries to appear above the horizon when they are really below it.

When the moon is full at 12 degrees from either of her nodes, she just touches the earth's shadow, but enters not into it. In Plate XLVII. fig. 3. let *GH* be the ecliptic, *ef* the moon's orbit where she is 12 degrees from the node at her full; *cd* her orbit where she is 6 degrees from the node, *ab* her orbit where she is full in the node, *AB* the earth's shadow, and *M* the moon. When the



the moon describes the line *ef*, she just touches the shadow, but does not enter into it; when she describes the line *cd*, she is totally, though not centrally, immersed in the shadow; and when she describes the line *ab*, she passes by the node at *M* in the centre of the shadow, and takes the longest line possible, which is a diameter, thro' it: And such an eclipse being both total and central is of the longest duration, namely, 3 hours 57 minutes 6 seconds from the beginning to the end, if the moon be at her greatest distance from the earth; and 3 hours 37 minutes 26 seconds, if she be at her least distance. The reason of this difference is, that when the moon is farthest from the earth, she moves slowest; and when nearest to it, quickest.

The moon's diameter, as well as the sun's, is supposed to be divided into twelve equal parts, called *digits*; and so many of these parts as are darkened by the earth's shadow, so many digits is the moon eclipsed. All that the moon is eclipsed above 12 digits, shew how far the shadow of the earth is over the body of the moon, on that edge to which she is nearest at the middle of the eclipse.

It is difficult to observe exactly either the beginning or ending of a lunar eclipse, even with a good telescope; because the earth's shadow is so faint and ill defined about the edges, that when the moon is either just touching or leaving it, the obscuration of her limb is scarce sensible; and therefore the nicest observers can hardly be certain to four or five seconds of time. But both the beginning and ending of solar eclipses are visibly instantaneous; for the moment that the edge of the moon's disk touches the sun's, his roundness seems a little broke on that part; and the moment she leaves it, he appears perfectly round again.

In astronomy, eclipses of the moon are of great use for ascertaining the periods of her motions; especially such eclipses as are observed to be alike in all her circumstances, and have long intervals of time between them. In geography, the longitudes of places are found by eclipses: But for this purpose eclipses of the moon are more useful than those of the sun, because they are more frequently visible, and the same lunar eclipse is of equal largeness and duration at all places where it is seen. In chronology, both solar and lunar eclipses serve to determine exactly the time of any past event: for there are so many particulars observable in every eclipse, with respect to its quantity, the places where it is visible (if of the sun) and the time of the day or night, that it is impossible there can be two solar eclipses in the course of many ages which are alike in all circumstances.

From the above explanation of the doctrine of eclipses it is evident, that the darkness at our Saviour's crucifixion was supernatural. For he suffered on the day on which the passover was eaten by the Jews, on which day it was impossible that the moon's shadow could fall on the earth; for the Jews kept the passover at the time of full moon: Nor does the darkness in total eclipses of the sun last above four minutes in any place; whereas the darkness at the crucifixion lasted three hours, Matth. xxviii. 15. and overspread at least all the land of Judea.

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With regard to the method of calculating and projecting eclipses, we must refer the reader to the astronomical tables of Mr Ferguson and others. When the principles are explained, the application and use of the tables is a matter of small difficulty, and easily acquired by a little practice.

## CHAP. XVII. *Of the fixed Stars.*

THE stars are said to be fixed, because they have been generally observed to keep at the same distances from each other: their apparent diurnal revolutions being caused solely by the earth's turning on its axis. They appear of a sensible magnitude to the bare eye, because the retina is affected not only by the rays of light which are emitted directly from them, but by many thousands more, which, falling upon our eye-lids, and upon the aerial particles about us, are reflected into our eyes so strongly as to excite vibrations not only in those points of the retina where the real images of the stars are formed, but also in other points at some distance round about. This makes us imagine the stars to be much bigger than they would appear, if we saw them only by the few rays which come directly from them, so as to enter our eyes without being intermixed with others. Any one may be sensible of this, by looking at a star of the first magnitude through a long narrow tube; which, though it takes in as much of the sky as would hold a thousand such stars, yet scarce renders *that* one visible.

The more a telescope magnifies, the less is the aperture through which the star is seen; and consequently the fewer rays it admits into the eye. Now since the stars appear less in a telescope which magnifies 200 times, than they do to the bare eye, insomuch that they seem to be only indivisible points, it proves at once that the stars are at immense distances from us, and that they shine by their own proper light. If they shone by borrowed light, they would be as invisible without telescopes as the satellites of Jupiter are; for these satellites appear bigger when viewed with a good telescope than the largest fixed stars do.

The number of stars discoverable, in either hemisphere, by the naked eye, is not above a thousand. This at first may appear incredible, because they seem to be without number: But the deception arises from our looking confusedly upon them, without reducing them into order. For, look but steadfastly upon a pretty large portion of the sky, and count the number of stars in it, and you will be surpris'd to find them so few. Or, if one considers how seldom the moon meets with any stars in her way, although there are as many about her path as in other parts of the heavens, he will soon be convinced that the stars are much thinner sown than he was aware of. The British catalogue, which, besides the stars visible to the bare eye, includes a great number which cannot be seen without the assistance of a telescope, contains no more than three thousand, in both hemispheres.

As we have incomparably more light from the moon than from all the stars together, it were the greatest ab-

furdity to imagine that the stars were made for no other purpose than to cast a faint light upon the earth; especially since many more require the assistance of a good telescope to find them out, than are visible without that instrument. Our sun is surrounded by a system of planets and comets; all which would be invisible from the nearest fixed star. And from what we already know of the immense distance of the stars, the nearest may be computed at 32,000,000,000,000 of miles from us, which is farther than a cannon-bullet would fly in 7,000,000 of years. Hence it is easy to prove, that the sun, seen from such a distance, would appear no bigger than a star of the first magnitude. From all this it is highly probable, that each star is a sun to a system of worlds moving round it, though unseen by us; especially as the doctrine of a plurality of worlds is rational, and greatly manifests the power, wisdom, and goodness of the great Creator.

The stars, on account of their apparently various magnitudes, have been distributed into several classes, or orders. Those which appear largest, are called *stars of the first magnitude*; the next to them in lustre, *stars of the second magnitude*; and so on the *sixth*, which are the smallest that are visible to the bare eye. This distribution having been made long before the invention of telescopes, the stars which cannot be seen without the assistance of these instruments, are distinguished by the name of *telescopic stars*.

The ancients divided the starry sphere into particular constellations, or systems of stars, according as they lay near one another, so as to occupy those spaces which the figures of different sorts of animals or things would take up, if they were there delineated. And those stars which could not be brought into any particular constellation, were called *unformed stars*.

This division of the stars into different constellations or asterisms, serves to distinguish them from one another, so that any particular star may be readily found in the heavens by means of a celestial globe; on which the constellations are so delineated, as to put the most remarkable stars into such parts of the figures as are most easily distinguished. The number of the ancient constellations is 48, and upon our present globes about 70. On Senner's globes are inserted Bayer's letters; the first in the Greek alphabet being put to the biggest star in each constellation, the second to the next, and so on: By which

means, every star is as easily found as if a name were given to it. Thus, if the star  $\gamma$  in the constellation of the ram be mentioned, every astronomer knows as well what star is meant as if it were pointed out to him in the heavens.

There is also a division of the heavens into three parts. 1. The Zodiac ( $\zeta\omicron\delta\iota\alpha\kappa\tau\omicron\varsigma$ ) from  $\zeta\omicron\delta\iota\omicron\nu$ , *zodion*, an animal, because most of the constellations in it, which are twelve in number, are the figures of animals: As *Aries* the ram, *Taurus* the bull, *Gemini* the twins, *Cancer* the crab, *Leo* the lion, *Virgo* the virgin, *Libra* the balance, *Scorpio* the scorpion, *Sagittarius* the archer, *Capricornus* the goat, *Aquarius* the water-bearer, and *Pisces* the fishes. The zodiac goes quite round the heavens: it is about 16 degrees broad, so that it takes in the orbits of all the planets, and likewise the orbit of the moon. Along the middle of this zone or belt is the ecliptic, or circle which the earth describes annually as seen from the sun; and which the sun appears to describe as seen from the earth. 2. All that region of the heavens, which is on the north side of the zodiac, containing twenty-one constellations. And, 3. That on the south side, containing fifteen.

The ancients divided the zodiac into the above twelve constellations or signs in the following manner. They took a vessel with a small hole in the bottom, and having filled it with water, suffered the same to distil drop by drop into another vessel set beneath to receive it; beginning at the moment when some star rose, and continuing until it rose the next following night. The water fallen down into the receiver they divided into twelve equal parts; and having two other small vessels in readiness, each of them fit to contain one part, they again poured all the water into the upper vessel, and observing the rising of some star in the zodiac, they at the same time suffered the water to drop into one of the small vessels; and as soon as it was full, they shifted it, and set an empty one in its place. When each vessel was full, they took notice what star of the zodiac rose; and though this could not be done in one night, yet in many they observed the rising of twelve stars or points, by which they divided the zodiac into twelve parts.

The names of the constellations, and the number of stars observed in each of them by different astronomers, are as follow.

The ancient Constellations.		Ptolemy.	Tycho.	Hevelius.	Flamsteed.
Ursa minor	The Little Bear	8	7	12	24
Ursa major	The Great Bear	35	29	73	87
Draco	The Dragon	31	32	40	80
Cepheus	Cepheus	13	4	51	35
Bootes, <i>Arctophilax</i>		23	18	52	54
Corona Borealis	The Northern Crown	8	8	8	21
Hercules, <i>Engonasin</i>	Hercules kneeling	29	28	45	113
Lyra	The Harp	10	11	17	21
Cygnus, <i>Gallina</i>	The Swan	19	18	47	81
Castropea	The Lady in her Chair	13	26	37	55
Perseus	Perseus	29	29	46	59
Auriga	The Waggoner	14	9	40	66
Serpentarius, <i>Ophiuchus</i>	Serpentarius	29	15	40	74

Serpens

The ancient Constellations.		Ptolemy.	Tycho.	Hevelius.	Flamsteed.
Serpens	The Serpent	18	13	22	64
Sagitta	The Arrow	5	5	5	18
Aquila, <i>Vultur</i>	The Eagle	15	12	23	71
Antinous	Antinous		3	19	
Delphinus	The Dolphin	10	10	14	18
Equulus, <i>Equi sectio</i>	The Horse's Head	4	4	6	10
Pegasus, <i>Equus</i>	The Flying Horse	20	19	38	89
Andromeda	Andromeda	23	23	47	66
Triangulum	The Triangle	4	4	12	16
Aries	The Ram	18	21	27	66
Taurus	The Bull	44	43	51	141
Gemini	The Twins	25	25	38	85
Cancer	The Crab	23	15	29	83
Leo	The Lion	35	30	49	95
Coma Berenices	Berenice's Hair		14	21	43
Virgo	The Virgin	32	33	50	110
Libra, <i>Chela</i>	The Scales	17	10	20	51
Scorpius	The Scorpion	24	10	20	44
Sagittarius	The Archer	31	14	22	69
Capricornus	The Goat	28	28	29	51
Aquarius	The Water-bearer	45	41	47	108
Pisces	The Fishes	38	36	39	113
Cetus	The Whale	22	21	45	97
Orion	Orion	38	42	62	78
Eridanus, <i>Fluvius</i>	Eridanus, the River	34	10	27	84
Lepus	The Hare	12	13	16	19
Canis major	The Great Dog	29	13	21	31
Canis minor	The Little Dog	2	2	13	14
Argo Navis	The Ship	45	3	4	64
Hydra	The Hydra	27	19	31	60
Crater	The Cup	7	3	10	31
Corvus	The Crow	7	4		9
Centaurus	The Centaur	57			35
Lupus	The Wolf	19			24
Ara	The Altar	7			9
Corona Australis	The Southern Crown	13			12
Pisces Australis	The Southern Fish	18			24

The new Southern Constellations.

				Hevel.	Flamstf.
Columba Noachi	Noah's Dove	10	Asterion & Chara	The Greyhounds	23 25
Robur Carolinum	The Royal Oak	12	Cerberus	Cerberus	4
Grus	The Crane	13	Vulpecula & Anser	The Fox and Goofe	27 35
Phoenix	The Phenix	13	Scutum Sobieski	Sobieski's Shield	7
Indus	The Indian	12	Lacerta	The Lizard	10 16
Pavo	The Peacock	14	Camelopardalus	The Camelopard	32 58
Apus, <i>Avis Indica</i>	The Bird of Paradise	11	Monocerns	The Unicorn	19 31
Apis, <i>Musca</i>	The Bee or Fly	4	Sextans	The Sextant	11 41
Chamaeleon	The Chameleon	10			
Triangulum Australis	The South Triangle	5			
Pisces volans, <i>Passer</i>	The Flying Fish	8			
Dorado, <i>Xiphias</i>	The Sword Fish	6			
Toucan	The American Goofe	9			
Hydrus	The Water Snake	10			

Hevelius's Constellations made out of the unformed Stars.

		Hevel.	Flamstf.
Lynx	The Lynx	19	44
Leo minor	The Little Lion		53

There is a remarkable track round the heavens, called the *Milky Way*, from its peculiar whiteness, which was formerly thought to be owing to a vast number of very small stars therein: but the telescope shews it to be quite otherwise; and therefore its whiteness must be owing to some other cause. This track appears single in some parts, in others double.

There are several little whitish spots in the heavens, which appear magnified, and more luminous when seen through telescopes; yet without any stars in them. One of these is in Andromeda's girdle, and was first observed A. D. 1612, by Simon Marius: it has some whitish rays.

rays near its middle, is liable to several changes, and is sometimes invisible. Another is near the ecliptic, between the head and bow of Sagittarius: it is small, but very luminous. A third is on the back of the Centaur, which is too far south to be seen in Britain. A fourth, of a smaller size, is before Antinous's right foot; having a star in it, which makes it appear more bright. A fifth is in the constellation of Hercules, between the stars  $\zeta$  and  $\eta$ , which spot, though but small, is visible to the bare eye, if the sky be clear and the moon absent.

*Cloudy stars* are so called from their misty appearances. They look like dim stars to the naked eye; but through a telescope they appear broad illuminated parts of the sky; in some of which is one star, in others more. Five of these are mentioned by Ptolemy. 1. One at the extremity of the right hand of Perseus. 2. One in the middle of the Crab. 3. One unformed, near the sting of the Scorpion. 4. The eye of Sagittarius. 5. One in the head of Orion. In the first of these appear more stars through the telescope than in any of the rest, although 21 have been counted in the head of Orion, and above 40 in that of the Crab. Two are visible in the eye of Sagittarius without a telescope, and several more with it. Flamsteed observed a cloudy star in the bow of Sagittarius, containing many small stars; and the star  $d$  above Sagittarius's right shoulder is encompassed with several more. Both Cassini and Flamsteed discovered one between the Great and Little Dog, which is very full of stars visible only by the telescope. The two whitish spots near the south pole, called the *Magellanic Clouds* by Sailors, which to the bare eye resemble part of the Milky Way, appear through telescopes to be a mixture of small clouds and stars. But the most remarkable of all the cloudy stars is that in the middle of Orion's Sword, where seven stars (of which three are very close together) seem to shine through a cloud, very lucid near the middle, but faint and ill defined about the edges. It looks like a gap in the sky, through which one may see (as it were) part of a much brighter region. Although most of these spaces are but a few minutes of a degree in breadth, yet, since they are among the fixed stars, they must be spaces larger than what is occupied by our solar system; and in which there seems to be a perpetual uninterrupted day among numberless worlds, which no human art ever can discover.

Several stars are mentioned by ancient astronomers, which are not now to be found; and others are now visible to the bare eye which are not recorded in the ancient catalogues. Hipparchus observed a new star about 120 years before Christ; but he has not mentioned in what part of the heaven it was seen, although it occasioned his making a catalogue of the stars; which is the most ancient that we have.

The first new star that we have any good account of, was discovered by Cornelius Gemma on the 8th of November *A. D.* 1572, in the chair of Cassiopea. It sur-

passed Sirius in brightness and magnitude; and was seen for 16 months successively. At first it appeared bigger than Jupiter to some eyes, by which it was seen at mid-day: afterwards it decayed gradually both in magnitude and lustre, until March 1573, when it became invisible.

On the 13th of August 1596, David Fabricius observed the *Stella Mira*, or wonderful star, in the neck of the Whale; which has been since found to appear and disappear periodically, seven times in six years, continuing in the greatest lustre for 15 days together; and is never quite extinguished.

In the year 1600, William Jansenius discovered a changeable star in the neck of the Swan; which, in time, became so small as to be thought to disappear entirely, till the years 1657, 1658, and 1659, when it recovered its former lustre and magnitude; but soon decayed, and is now of the smallest size.

In the year 1604 Kepler and several of his friends saw a new star near the heel of the right foot of Serpentarius, so bright and sparkling, that it exceeded any thing they had ever seen before; and took notice that it was every moment changing into some of the colours of the rainbow, except when it was near the horizon, at which time it was generally white. It surpassed Jupiter in magnitude, which was near it all the month of October, but easily distinguished from Jupiter, by the steady light of Jupiter. It disappeared between October 1605 and the February following, and has not been seen since that time.

In the year 1670, July 15, Hevelius discovered a new star, which in October was so decayed as to be scarce perceptible. In April following it regained its lustre, but wholly disappeared in August. In March 1672 it was seen again, but very small; and has not been visible since.

In the year 1686 a new star was discovered by Kirch, which returns periodically in 404 days.

In the year 1672, Cassini saw a star in the neck of the Bull, which he thought was not visible in Tycho's time, nor when Bayer made his figures.

Many stars, besides those above mentioned, have been observed to change their magnitudes: and as none of them could ever be perceived to have tails, it is plain they could not be comets; especially as they had no parallax, even when largest and brightest. It would seem, that the periodical stars have vast clusters of dark spots, and very slow rotations on their axes; by which means, they must disappear when the side covered with spots is turned towards us. And as for those which break out all of a sudden with such lustre, it is by no means improbable that they are suns whose fuel is almost spent, and again supplied by some of their comets falling upon them, and occasioning an uncommon blaze and splendor for some time; which indeed appears to be the greatest use of the cometary part of any system\*.

Some

\* *M. Maupertuis, in his dissertation on the figures of the celestial bodies, (p. 61,—63.), is of opinion that some stars, by their prodigious quick rotations on their axes, may not only assume the figures of oblate spheroids, but that, by the great centrifugal force arising from such rotations, they may become of the figures of mill-stones;*

Some of the stars, particularly Arcturus, have been observed to change their places above a minute of a degree with respect to others. But whether this be owing to any real motion in the stars themselves, must require the observations of many ages to determine. If our solar system changeth its place, with regard to absolute space, this must in process of time occasion an apparent change in the distances of the stars from each other: and in such a case, the places of the nearest stars to us being more affected than those which are very remote, their relative positions must seem to alter, though the stars themselves were really immoveable. On the other hand, if our own system be at rest, and any of the stars in real motion, this must vary their positions; and the more so, the nearer they are to us, or swifter their motions are, or the more proper the direction of their motion is for our perception.

The obliquity of the ecliptic to the equinoctial is found at present to be above the third part of a degree less than Ptolemy found it. And most of the observers after him found it to decrease gradually down to Tycho's time. If it be objected, that we cannot depend on the observations of the ancients, because of the incorrectness of their instruments; we have to answer, that both Tycho and Flamsteed are allowed to have been very good observers; and yet we find that Flamsteed makes this obliquity  $2\frac{1}{2}$  minutes of a degree less than Tycho did about 100 years before him: and as Ptolemy was 1324 years before Tycho, so the gradual decrease answers nearly to the difference of time between these three astronomers. If we consider, that the earth is not a perfect sphere, but an oblate spheroid, having its axis shorter than its equatorial diameter; and that the sun and moon are constantly acting obliquely upon the greater quantity of matter about the equator, pulling it, as it were, towards a nearer and nearer co-incidence with the ecliptic; it will not appear improbable that these actions should gradually diminish the angle between those planes. Nor is it less probable that the mutual attractions of all the planets should have a tendency to bring their orbits to a coincidence: but this change is too small to become sensible in many ages.

CHAP. XVIII. *Of the Division of Time. A perpetual Table of New Moons. The Times of the Birth and Death of CHRIST. A Table of remarkable Eras or Events.*

THE parts of time are *Seconds, Minutes, Hours, Days, Years, Cycles, Ages, and Periods.*

The original standard, or integral measure of time,

is a year; which is determined by the revolution of some celestial body in its orbit, viz. the sun or moon.

The time measured by the sun's revolution in the ecliptic, from any equinox or solstice to the same again, is called the *Solar* or *Tropical Year*, which contains 365 days, 5 hours, 48 minutes, 57 seconds; and is the only proper or natural year, because it always keeps the same seasons to the same months.

The quantity of time measured by the sun's revolution, as from any fixed star to the same star again, is called the *sidereal year*; which contains 365 days 6 hours 9 minutes  $14\frac{1}{2}$  seconds; and is 20 minutes  $17\frac{1}{2}$  seconds longer than the true solar year.

The time measured by twelve revolutions of the moon, from the sun to the sun again, is called the *lunar year*; it contains 354 days 8 hours 48 minutes 36 seconds; and is therefore 10 days 21 hours 0 minutes 21 seconds shorter than the solar year. This is the foundation of the epact.

The *civil year* is that which is in common use among the different nations of the world; of which, some reckon by the lunar, but most by the solar. The civil solar year contains 365 days, for three years running, which are called *common years*; and then comes in what is called the *bissextile* or *leap-year*, which contains 366 days. This is also called the *Julian year*, on account of Julius Cæsar, who appointed the intercalary-day every fourth year, thinking thereby to make the civil and solar year keep pace together. And this day, being added to the 23d of February, which in the Roman calendar was the sixth of the kalends of March, that sixth day was twice reckoned, or the 23d and 24th were reckoned as one day, and was called *bis sextus dies*; and thence came the name *bissextile* for that year. But in our common almanacks this day is added at the end of February.

The *civil lunar year* is also common or intercalary. The common year consists of 12 lunations, which contain 354 days; at the end of which, the year begins again. The *intercalary*, or *embolimic year* is that wherein a month was added, to adjust the lunar year to the solar. This method was used by the Jews, who kept their account by the lunar motions. But by intercalating no more than a month of 30 days, which they called *Ve-Adar*, every third year, they fell  $3\frac{1}{2}$  days short of the solar year in that time.

The Romans also used the *lunar embolimic year* at first, as it was settled by Romulus their first king, who made it to consist only of ten months or lunations, which fell 61 days short of the solar year, and so their year became quite vague and unfix'd; for which reason, they were forced to have a table published by the high-priest, to inform them when the spring and other seasons began.

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or be reduced to flat circular planes, so thin as to be quite invisible when their edges are turned towards us; as Saturn's ring is in such positions. But when very excentric planets or comets go round any flat star, in orbits much inclined to its equator, the attraction of the planets or comets in their perihelions must alter the inclination of the axis of that star; on which account it will appear more or less large and luminous, as its broad side is more or less turned towards us. And thus he imagines we may account for the apparent changes of magnitude and lustre in those stars, and likewise for their appearing and disappearing.

But Julius Cæsar, as already mentioned, taking this troublesome affair into consideration, reformed the kalendar, by making the year to consist of 365 days 6 hours.

The year thus settled, is what we still make use of in Britain; but as it is somewhat more than 11 minutes longer than the solar tropical year, the times of the equinoxes go backward, and fall earlier by one day in about 130 years. In the time of the Nicene Council, (*A. D.* 325), which was 1444 years ago, the vernal equinox fell on the 21st of March; and if we divide 1444 by 130, it will quote 11, which is the number of days which the equinox has fallen back since the Council of Nice. This causing great disturbances, by unfixing the times of the celebration of Easter, and consequently of all the other moveable feasts, Pope Gregory XIIIth, in the year 1582, ordered ten days to be at once struck out of that year; and the next day after the 4th of October was called the 15th. By this means the vernal equinox was restored to the 21st of March; and it was endeavoured, by the omission of three intercalary days in 400 years, to make the civil or political year keep pace with the solar for time to come. This new form of the year is called the *Gregorian account*, or *new style*; which is received in all countries where the pope's authority is acknowledged, and ought to be in all places where truth is regarded.

The principal division of the year is into *months*, which are of two sorts, namely, *astronomical* and *civil*. The astronomical month is the time in which the moon

runs through the zodiac, and is either *periodical* or *synodical*. The periodical month is the time spent by the moon in making one complete revolution from any point of the zodiac to the same again; which is  $27^d 7^h 43^m$ . The synodical month, called a *lunation*, is the time contained between the moon's parting with the sun at a conjunction, and returning to him again, which is  $29^d 12^h 44^m$ . The civil months are those which are framed for the uses of civil life; and are different as to their names, number of days, and times of beginning, in several different countries. The first month of the Jewish year fell according to the moon in our August and September, old style; the second in September and October; and so on. The first month of the Egyptian year began on the 29th of our August. The first month of the Arabic and Turkish year began the 16th of July. The first month of the Grecian year fell according to the moon in June and July, the second in July and August, and so on, as in the following table.

A month is divided into four parts called *weeks*, and a week into seven parts called *days*; so that in a Julian year there are 13 such months, or 52 weeks, and one day over. The Gentiles gave the names of the sun, moon, and planets, to the days of the week. To the first, the name of the *Sun*; to the second, of the *Moon*; to the third, of *Mars*; to the fourth, of *Mercury*; to the fifth, of *Jupiter*; to the sixth, of *Venus*; and to the seventh, of *Saturn*.

N <sup>o</sup>	The Jewish year.	Days	N <sup>o</sup>	The Egyptian year.	Days
1	Tisri ————— Aug.—Sept.	30	1	Thoth ————— August 29	30
2	Marchesvan ——— Sept.—Oct.	29	2	Paophi ————— Septemb. 28	30
3	Chisleu ————— Oct.—Nov.	30	3	Athir ————— October 28	30
4	Tebeth ————— Nov.—Dec.	29	4	Chojac ————— Novemb. 27	30
5	Shebat ————— Dec.—Jan.	30	5	Tybi ————— Decemb. 27	30
6	Adar ————— Jan.—Feb.	29	6	Mechir ————— January 26	30
7	Nisan or Abib ——— Feb.—Mar.	30	7	Phamemoth ——— February 25	30
8	Jiar ————— Mar.—Apr.	29	8	Parmuthi ——— March 27	30
9	Sivan ————— Apr.—May	30	9	Pachon ————— April 26	30
10	Tamuz ————— May—June	29	10	Payni ————— May 26	30
11	Ab ————— June—July	30	11	Epiphi ————— June 25	30
12	Elul ————— July—Aug.	29	12	Mefori ————— July 25	30
Days in the year —————		354	Epagomenæ or days added ———		5
In the embolismic year after Adar they added a month called <i>Ve-Adar</i> of 30 days.			Days in the year —————		365

N <sup>o</sup>	The Arabic and Turkish year.	Days	N <sup>o</sup>	The ancient Grecian year.	Days	
1	Muharram ——— July 16	30	1	Hecatombæon ——— June—July	30	
2	Saphar ——— August 15	29	2	Metagitnion ——— July—Aug.	29	
3	Rabia I. ——— Septemb. 13	30	3	Boedromion ——— Aug.—Sept.	30	
4	Rabia II. ——— October 13	29	4	Pyanepfion ——— Sept.—Oct.	29	
5	Jomada I. ——— Novemb. 11	30	5	Maimacterion ——— Oct.—Nov.	30	
6	Jomada II. ——— Decemb. 11	29	6	Posideon ——— Nov.—Dec.	29	
7	Rajab ——— January 9	30	7	Gamelion ——— Dec.—Jan.	30	
8	Shaiban ——— February 8	29	8	Antheftion ——— Jan.—Feb.	29	
9	Ramadam ——— March 9	30	9	Elaphebolion ——— Feb.—Mar.	30	
10	Shawāl ——— April 8	29	10	Munichion ——— Mar.—Apr.	29	
11	Dulhaadah ——— May 7	30	11	Thargelion ——— Apr.—May	30	
12	Dulheggia ——— June 5	29	12	Schirrophorion ——— May—June	29	
Days in the year ————			354	Days in the year ————		354
The Arabians add 11 days at the end of every year, which keep the same months to the same seasons.						

A day is either natural or artificial. The natural day contains 24 hours; the artificial the time from sunrise to sun-set. The natural day is either astronomical or civil. The astronomical day begins at noon, because the increase and decrease of days terminated by the horizon are very unequal among themselves; which inequality is likewise augmented by the inconstancy of the horizontal refractions, and therefore the astronomer takes the meridian for the limit of diurnal revolutions, reckoning noon, that is, the instant when the sun's centre is on the meridian, for the beginning of the day. The British, French, Dutch, Germans, Spaniards, Portuguese, and Egyptians, begin the civil day at midnight; the ancient Greeks, Jews, Bohemians, Silesians, with the modern Italians, and Chinese, begin it at sun-setting; and the ancient Babylonians, Persians, Syrians, with the modern Greeks, at sun-rising.

An hour is a certain determinate part of the day, and is either equal or unequal. An equal hour is the 24th part of a mean natural day, as shewn by well-regulated clocks and watches; but these hours are not quite equal as measured by the returns of the sun to the meridian, because of the obliquity of the ecliptic and sun's unequal motion in it. Unequal hours are those by which the artificial day is divided into twelve parts, and the night into as many.

An hour is divided into 60 equal parts called minutes, a minute into 60 equal parts called seconds, and these again into 60 equal parts called thirds. The Jews, Chaldeans, and Arabians, divide the hour into 1080 equal parts called scruples; which number contains 18 times 60, so that one minute contains 18 scruples.

A cycle is a perpetual round, or circulation of the same parts of time of any sort. The cycle of the sun is a revolution of 28 years, in which time the days of the months return again to the same days of the week; the sun's place to the same signs and degrees of the ecliptic on the same months and days, so as not to differ one degree in 100 years; and the leap-years begin the

same course over again with respect to the days of the week on which the days of the months fall. The cycle of the moon, commonly called the golden number, is a revolution of 19 years; in which time, the conjunctions, oppositions, and other aspects of the moon, are within an hour and half of being the same as they were on the same days of the months 19 years before. The indiction is a revolution of 15 years, used only by the Romans for indicating the times of certain payments made by the subjects to the republic: It was established by Constantine, A. D. 312.

The year of our Saviour's birth, according to the vulgar æra, was the 9th year of the solar cycle, the first year of the lunar cycle, and the 312th year after his birth was the first year of the Roman indiction. Therefore, to find the year of the solar cycle, add 9 to any given year of Christ, and divide the sum by 28, the quotient is the number of cycles elapsed since his birth, and the remainder is the cycle for the given year: If nothing remains, the cycle is 28. To find the lunar cycle, add 1 to the given year of Christ, and divide the sum by 19; the quotient is the number of cycles elapsed in the interval, and the remainder is the cycle for the given year: If nothing remains, the cycle is 19. Lastly, subtract 312 from the given year of Christ; and divide the remainder by 15; and what remains after this division is the indiction for the given year: If nothing remains, the indiction is 15.

Although the above deficiency in the lunar circle of an hour and an half every 19 years be but small, yet in time it becomes so sensible as to make a whole natural day in 310 years. So that, although this cycle be of use, when the golden numbers are rightly placed against the days of the months in the kalendar, as in our Common Prayer Books, for finding the days of the mean conjunctions or oppositions of the sun and moon, and consequently the time of Easter; it will only serve for 310 years, old style. For as the new and full moons anticipate a day in that time, the golden numbers ought to

to be placed one day earlier in the kalendar for the next 310 years to come. These numbers were rightly placed against the days of new moon in the kalendar, by the council of Nicæ, A. D. 325; but the anticipation, which has been neglected ever since, is now grown almost into 5 days: And therefore, all the golden numbers ought now to be placed 5 days higher in the kalendar for the old style than they were at the time of the said council; or 6 days lower for the new style, because at present it differs 11 days from the old.

Days.	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1			9	17	17	6				11		19
2	9	17			6	14	14	3	11		19	8
3	17	6	17	6			3	11		19	8	16
4	6		6	14	14	3			19	8		
5		14			3	11	11	19			16	
6	14	3	14	3			19			16	5	5
7	3		3	11	11	19	8	16	5	5	13	
8		11			19	8	8	16		13		2
9	11	19	11	19	8	16	16	5	13		2	10
10			19	8	8	16						
11	19	8					5	13	2	2	10	
12	8	16	8	16	16	5			10	10		18
13					5	13	13	2	10	18	7	
14	16	5	16	5			2	10	18	18	7	
15	5		5	13	13	2				7		15
16		13			2	10	10	18	7		15	
17	13	2	13	2			18	7		15	4	4
18	2		2	10	10	18			15			12
19		10			18	7	7	15	4	4	12	
20	10	18	10	18			15			12	1	1
21												
22	18		18	7	7	15		4	12			9
23		7		15	15	4	4	12	1	1	9	
24	7	15	7	15			12			9	17	17
25			15	4	4	12		1	9	17	17	6
26	15	4			12							
27		4	4	12		1				6		15
28		12		1	1	9	9	17	6	14	14	3
29	1		1	9		17				3		11
30					17	6	6	14	3			
31	9		9				14	3		11		19

In the above table the golden numbers under the months stand against the days of new moon in the left-hand column, for the new style; adapted chiefly to the second year after leap-year, as being the nearest mean for all the four; and will serve till the year 1900. Therefore, to find the day of new moon in any month of a given year till that time, look for the golden number of

that year under the desired month, and against it you have the day of new moon in the left-hand column. Thus, suppose it were required to find the day of new moon in September 1769; the golden number for that year is 3, which I look for under September, and right against it in the left-hand column you will find 30, which is the day of new moon in that month. *N. B.* If all the golden numbers, except 17 and 6, were set one day lower in the table, it would serve from the beginning of the year 1900 till the end of the year 2199. The table at the end of this chapter shews the golden number for 4000 years after the birth of Christ, by looking for the even hundreds of any given year at the left hand, and for the rest to make up that year at the head of the table; and where the columns meet, you have the golden number (which is the same both in old and new style) for the given year. Thus, suppose the golden number was wanted for the year 1769; look for 1700 at the left hand of the table, and for 69 at the top of it; then guiding your eye downward from 69 to over-against 1700, you will find 3, which is the golden number for that year.

But because the lunar cycle of 19 years sometimes includes five leap-years, and at other times only four, this table will sometimes vary a day from the truth in leap-years after February. And it is impossible to have one more correct, unless we extend it to four times 19 or 76 years; in which there are 19 leap-years without a remainder. But even then to have it of perpetual use, it must be adapted to the old style; because, in every centennial year not divisible by 4, the regular course of leap-years is interrupted in the new; as will be the case in the year 1800.

The cycle of Easter, also called the *Dionysian period*, is a revolution of 532 years, found by multiplying the solar cycle 28 by the lunar cycle 19. If the new moons did not anticipate upon this cycle, Easter-day would always be the Sunday next after the first full moon, which follows the 21st of March. But, on account of the above anticipation, to which no proper regard was had before the late alteration of the style, the ecclesiastic Easter has several times been a week different from the true Easter within this last century: which inconvenience is now remedied by making the table, which used to find Easter for ever, in the Common Prayer Book, of no longer use than the lunar difference from the new style will admit of.

The earliest Easter possible is the 22d of March, the latest the 25th of April. Within these limits are 35 days, and the number belonging to each of them is called the *number of direction*; because thereby the time of Easter is found for any given year.

The first seven letters of the alphabet are commonly placed in the annual almanacks, to shew on what days of the week the days of the months fall throughout the year. And because one of those seven letters must necessarily stand against Sunday, it is printed in a capital form, and called the *dominical letter*: The other six being inserted in small characters, to denote the other six days of the week. Now, since a common Julian year contains 365 days, if this number be divided by 7 (the



(the number of days in a week) there will remain one day. If there had been no remainder, it is plain the year would constantly begin on the same day of the week: but since one remains, it is plain, that the year must begin and end on the same day of the week; and therefore the next year will begin on the day following. Hence, when January begins on Sunday, *A* is the dominical or Sunday letter for that year: Then, because the next year begins on Monday, the Sunday will fall on the seventh day, to which is annexed the seventh letter *G*, which therefore will be the dominical letter for all that year: and as the third year will begin on Tuesday, the Sunday will fall on the sixth day; therefore *F* will be the Sunday letter for that year. Whence it is evident, that the Sunday letters will go annually in a retrograde order thus, *G, F, E, D, C, B, A*. And, in the course of seven years, if they were all common ones, the same days of the week and dominical letters would return to the same days of the months. But because there are 366 days in a leap-year, if this number be divided by 7, there will remain two days over and above the 52 weeks of which the year consists. And therefore, if the leap-year begins on Sunday, it will end on Monday; and the next year will begin on Tuesday, the first Sunday whereof must fall on the sixth of January, to which is annexed the letter *F*, and not *G*, as in common years. By this means, the leap-year returning every fourth year, the order of the dominical letters is interrupted; and the series cannot return to its first state till after four times seven, or 28 years; and then the same days of the months return in order to the same days of the week as before.

From the multiplication of the solar cycle of 28 years into the lunar cycle of 19 years, and the Roman indiction of 15 years, arises the great Julian period, consisting of 7980 years, which had its beginning 764 years before Strauchius's supposed year of the creation (for no later could all the three cycles begin together) and it is not yet completed: And therefore it includes all other cycles, periods, and æras. There is but one year in the whole period that has the same numbers for the three cycles of which it is made up: And therefore, if historians had remarked in their writings the cycles of each year, there had been no dispute about the time of any action recorded by them.

The Dionysian or vulgar æra of Christ's birth was about the end of the year of the Julian period 4713; and consequently the first year of his age, according to that

account, was the 4714th year of the said period. Therefore, if to the current year of Christ we add 4713, the sum will be the year of the Julian period. So the year 1769 will be found to be the 6482d year of that period. Or, to find the year of the Julian period answering to any given year before the first year of Christ, subtract the number of that given year from 4714, and the remainder will be the year of the Julian period. Thus, the year 585 before the first year of Christ (which was the 584th before his birth) was the 4129th year of the said period. Lastly, to find the cycles of the sun, moon, and indiction for any given year of this period, divide the given year by 28, 19, and 15; the three remainders will be the cycles sought, and the quotients the numbers of cycles run since the beginning of the period. So in the above 4714th year of the Julian period, the cycle of the sun was 10, the cycle of the moon 2, and the cycle of indiction 4; the solar cycle having run through 168 courses, the lunar 248, and the indiction 314.

The vulgar æra of Christ's birth was never settled till the year 527, when Dionysius Exiguus, a Roman abbot, fixed it to the end of the 4713th year of the Julian period, which was four years too late. For our Saviour was born before the death of Herod, who sought to kill him as soon as he heard of his birth. And, according to the testimony of Josephus (*B. xvii. ch. 8.*) there was an eclipse of the moon in the time of Herod's last illness; which eclipse appears by our astronomical tables to have been in the year of the Julian period 4710, March 13th, at 3 hours past midnight, at Jerusalem. Now, as our Saviour must have been born some months before Herod's death, since in the interval he was carried into Egypt, the latest time in which we can fix the true æra of his birth as about the end of the 4709th year of the Julian period.

As there are certain fixed points in the heavens from which astronomers begin their computations, so there are certain points of time from which historians begin to reckon; and these points or roots of time are called *æras* or *epochs*. The most remarkable æras are, those of the Creation, the Greek Olympiads, the building of Rome, the æra of Nabonassar, the death of Alexander, the birth of Christ, the Arabian Hegira, and the Persian Jeshdegird: All which, together with several others of less note, have their beginnings to the following table fixed to the years of the Julian period, to the age of the world at those times, and to the years before and after the year of Christ's birth.

*A Table of remarkable Æras and Events.*

	Julian Period.	Y. of the World.	Before Christ.
1. The creation of the world	706	0	4007
2. The deluge, or Noah's flood	2362	1656	2351
3. The Assyrian monarchy founded by Nimrod	2537	1831	2176
4. The birth of Abraham	2714	2008	1999
5. The destruction of Sodom and Gomorrah	2816	2110	1897
6. The beginning of the kingdom of Athens by Cecrops	3157	2451	1556
7. Moses receives the ten commandments from God	3222	2516	1491
8. The entrance of the Israelites into Canaan	3262	2556	1451
9. The destruction of Troy	3529	2823	1184

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10. The

	Julian Period.	Y. of the Word.	Before Christ.
10. The beginning of king David's reign	3650	2944	1063
11. The foundation of Solomon's temple	3701	2995	1012
12. The Argonautic expedition	3776	3070	937
13. Lycurgus forms his excellent laws	3829	3103	884
14. Arbaces, the first king of the Medes	3838	3132	875
15. Mandaucus, the second	3865	3159	848
16. Sofarmus, the third	3915	3209	798
17. The beginning of the Olympiads	3938	3232	775
18. Artica, the fourth king of the Medes	3945	3239	768
19. The Catonian epocha of the building of Rome	3961	3255	752
20. The æra of Nabonassar	3967	3261	746
21. The destruction of Samaria by Salmaneser	3992	3286	721
22. The first eclipse of the moon on record	3993	3287	720
23. Cardicea, the fifth king of the Medes	3996	3290	717
24. Phraortes, the sixth	4058	3352	655
25. Cyaxares, the seventh	4080	3374	633
26. The first Babylonish captivity by Nebuchadnezzar	4107	3401	606
27. The long war ended between the Medes and Lydians	4111	3405	602
28. The second Babylonish captivity, and birth of Cyrus	4114	3408	599
29. The destruction of Solomon's temple	4125	3419	588
30. Nebuchadnezzar struck with madness	4144	3438	569
31. Daniel's vision of the four monarchies	4158	3452	555
32. Cyrus begins to reign in the Persian empire	4177	3471	536
33. The battle of Marathon	4223	3517	490
34. Artaxerxes Longimanus begins to reign	4249	3543	464
35. The beginning of Daniel's seventy weeks of years	4256	3550	457
36. The beginning of the Peloponnesian war	4282	3576	431
37. Alexander's victory at Arbela	4383	3677	330
38. The death of Alexander	4390	3684	323
39. The captivity of 100000 Jews by king Ptolemy	4393	3687	320
40. The Colossus of Rhodes thrown down by an earthquake	4491	3785	222
41. Antiochus defeated by Ptolemy Philopater	4496	3790	217
42. The famous Archimedes murdered at Syracuse	4506	3800	207
43. Jason butchers the inhabitants of Jerusalem	4543	3837	170
44. Corinth plundered and burnt by consul Mummius	4567	3861	146
45. Julius Cæsar invades Britain	4659	3953	54
46. He corrects the calendar	4677	3961	46
47. Is killed in the Senate-house	4671	3965	42
48. Herod made king of Judea	4673	3967	40
49. Anthony defeated at the Battle of Actium	4683	3977	30
50. Agrippa builds the Pantheon at Rome	4688	3982	25
51. The true æra of Christ's birth	4709	4003	4
52. The death of Herod	4710	4004	3
			After Christ.
53. The Dionysian, or vulgar æra of Christ's birth	4713	4007	0
54. The true year of his crucifixion	4746	4040	33
55. The destruction of Jerusalem	4783	4077	70
56. Adrian builds the long wall in Britain	4833	4127	120
57. Constantius defeats the Picts in Britain	5019	4313	306
58. The council of Nice	5038	4332	325
59. The death of Constantine the great	5050	4344	337
60. The Saxons invited into Britain	5158	4452	445
61. The Arabian Hegira	5335	4629	622
62. The death of Mohammed the pretended prophet	5343	4637	630
63. The Persian Yefdegird	5344	4638	631
64. The sun, moon, and all the planets in Libra, Sep. 14. as seen from the earth	5899	5193	1186
65. The art of printing discovered	6153	5447	1440
66. The reformation begun by Martin Luther	6230	5524	1517

In fixing the year of the creation to the 706th year of the Julian period, which was the 4007th year before the year of Christ's birth, we have followed Mr Bedford in his scripture chronology, printed A. D. 1730, and Mr Kennedy in a work of the same kind, printed A. D. 1762.—Mr Bedford takes it only for granted that the world was created at the time of the autumnal equinox: But Mr Kennedy affirms, that the said equinox

was at the noon of the fourth day of the creation-week, and that the moon was then 24 hours past her opposition to the sun.—If Moses had told us the same things, we should have had sufficient *data* for fixing the æra of the creation: But, as he has been silent on these points, we must consider the best accounts of chronologers as entirely hypothetical and uncertain.

TABLE, shewing the Golden Number, (which is the same both in the Old and New Style), from the Christian Era, to A. D. 4000.

			Years less than an hundred.																			
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Hundreds of Years.	19	38	20	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	
	57	76	58	77	59	78	60	79	61	80	62	81	63	82	64	83	65	84	66	85	67	
	68	87	69	88	70	89	71	90	72	91	73	92	74	93	75	94	76	95	77	96	78	
	97	116	98	117	99	118	100	119	101	120	102	121	103	122	104	123	105	124	106	125	107	
	126	145	127	146	128	147	129	148	130	149	131	150	132	151	133	152	134	153	135	154	136	
100	1900	3800	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
200	2100	4000	6	7	8	9	10	11	12	13	14	15	16	17	18	19	1	2	3	4	5	
300	2200	&c.	11	12	13	14	15	16	17	18	19	1	2	3	4	5	6	7	8	9	10	
400	2300	—	16	17	18	19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
500	2400	—	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	1	
600	2500	—	7	8	9	10	11	12	13	14	15	16	17	18	19	1	2	3	4	5	6	
700	2600	—	12	13	14	15	16	17	18	19	1	2	3	4	5	6	7	8	9	10	11	
800	2700	—	17	18	19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
900	2800	—	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	1	2	
1000	2900	—	8	9	10	11	12	13	14	15	16	17	18	19	1	2	3	4	5	6	7	
1100	3000	—	13	14	15	16	17	18	19	1	2	3	4	5	6	7	8	9	10	11	12	
1200	3100	—	18	19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1300	3200	—	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	1	2	3	
1400	3300	—	9	10	11	12	13	14	15	16	17	18	19	1	2	3	4	5	6	7	8	
1500	3400	—	14	15	16	17	18	19	1	2	3	4	5	6	7	8	9	10	11	12	13	
1600	3500	—	19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1700	3600	—	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	1	2	3	4	
1800	3700	—	10	11	12	13	14	15	16	17	18	19	1	2	3	4	5	6	7	8	9	
			15	16	17	18	19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

CHAP. XIX. *A Description of the Astronomical Machinery serving to explain and illustrate the foregoing part of this Treatise.*

THE ORRERY, (Plate XLVII. fig. 4.) This machine shews the motions of the sun, Mercury, Venus, earth, and moon; and occasionally the superior planets, Mars, Jupiter, and Saturn, may be put on; Jupiter's four satellites are moved round him in their proper times by a small winch; and Saturn has his five satellites, and his ring which keeps its parallelism round the sun; and by a lamp put in the sun's place, the ring shews all its various phases already described.

In the centre, No. 1. represents the sun, supported by its axis, inclining almost 8 degrees from the axis of

the ecliptic, and turning round in  $25\frac{1}{4}$  days on its axis, of which the north pole inclines toward the 8th degree of Pices in the great ecliptic, (No. 11.), whereon the months and days are engraven over the signs and degrees in which the sun appears, as seen from the earth, on the different days of the year.

The nearest planet (No. 2.) to the sun is Mercury, which goes round him in 87 days 23 hours, or  $87\frac{2}{3}$  diurnal rotations of the earth; but has no motion round its axis in the machine, because the time of its diurnal motion in the heavens is not known to us.

The next planet in order is Venus, (No. 3.), which performs her annual course in 224 days 17 hours, and turns round her axis in 24 days 8 hours, or in  $24\frac{1}{3}$  diurnal rotations of the earth. Her axis inclines 75 degrees from the axis of the ecliptic, and her north pole inclines towards

towards the 20th degree of Aquarius, according to the observations of Bianchini. She shews all the phenomena described in Chap. I.

Next, without the orbit of Venus, is the Earth, (No. 4.), which turns round its axis, to any fixed point at a great distance, in 23 hours 56 minutes 4 seconds, of mean solar time; but from the sun to the sun again, in 24 hours of the same time. No. 6. is a syderal dial plate under the earth, and No 7. a solar dial-plate on the cover of the machine. The index of the former shews syderal. and of the latter, solar time; and hence the former index gains one entire revolution on the latter every year, as 365 solar or natural days contain 366 syderal days, or apparent revolutions of the stars. In the time that the earth makes  $365\frac{1}{4}$  diurnal rotations on its axis, it goes once round the sun in the plane of the ecliptic; and always keeps opposite to a moving index (No. 10.) which shews the sun's daily change of place, and also the days of the months.

The earth is half covered with a black cap, for dividing the apparently enlightened half next the sun from the other half, which, when turned away from him, is in the dark. The edge of the cap represents the circle bounding light and darkness, and shews at what time the sun rises and sets to all places throughout the year. The earth's axis inclines  $23\frac{1}{2}$  degrees from the axis of the ecliptic, the north pole inclines toward the beginning of Cancer, and keeps its parallelism throughout its annual course; so that in summer the northern parts of the earth incline towards the sun, and in winter from him; by which means, the different lengths of days and nights, and the cause of the various seasons, are demonstrated to sight.

There is a broad horizon, to the upper side of which is fixed a meridian semicircle in the north and south points, graduated on both sides from the horizon to  $90^\circ$  in the zenith or vertical point. The edge of the horizon is graduated from the east and west to the south and north points, and within these divisions are the points of the compass. From the lower side of this thin horizon-plate stand out four small wires, to which is fixed a twilight-circle  $18$  degrees from the graduated side of the horizon all round. This horizon may be put upon the earth, (when the cap is taken away), and rectified to the latitude of any place; and then, by a small wire called the *solar ray*, which may be put on so as to proceed directly from the sun's centre towards the earth's, but to come no farther than almost to touch the horizon. The beginning of twilight, time of sun-rising, with his amplitude, meridian altitude, time of setting, amplitude then, and end of twilight, are shewn for every day of the year, at that place to which the horizon is rectified.

The Moon (No. 5.) goes round the earth, from between it and any fixed point at a great distance, in 27 days 7 hours 43 minutes, or through all the signs and degrees of her orbit, which is called her *periodical revolution*; but she goes round from the sun to the sun again, or from change to change in 29 days 12 hours 45 minutes, which is her *synodical revolution*; and in that time she exhibits all the phases already described.

When the above mentioned horizon is rectified to the

latitude of any given place, the times of the moon's rising and setting, together with her amplitude, are shewn to that place as well as the sun's; and all the various phenomena of the harvest-moon are made obvious to sight.

The moon's orbit (No. 9.) is inclined to the ecliptic, (No. 11.), one half being above, and the other below it. The nodes, or points at  $\circ$  and  $\circ$ , lie in the plane of the ecliptic, as before described, and shift backward through all its signs and degrees in  $18\frac{1}{2}$  years. The degrees of the moon's latitude to the highest at *NL* (north latitude) and lowest at *SL*, (south latitude), are engraven both ways from her nodes at  $\circ$  and  $\circ$ ; and as the moon rises and falls in her orbit according to its inclination, her latitude and distance from her nodes are shewn for every day, having first rectified her orbit so as to set the nodes to their proper places in the ecliptic; and then, as they come about at different, and almost opposite times of the year, and then point towards the sun, all the eclipses may be shewn for hundreds of years, (without any new rectification), by turning the machinery backward for time past, or forward for time to come. At 17 degrees distance from each node, on both sides, is engraved a small sun; and at 12 degrees distance, a small moon; which shew the limits of solar and lunar eclipses: and when, at any change, the moon falls between either of these suns and the node, the sun will be eclipsed on the day pointed to by the annual index, (No. 10.): and as the moon has then north or south latitude, one may easily judge whether that eclipse will be visible in the northern or southern hemisphere; especially as the earth's axis inclines toward the sun or from him at that time. And when, at any full, the moon falls between either of the little moons and node, she will be eclipsed, and the annual index shews the day of that eclipse. There is a circle of  $29\frac{1}{2}$  equal parts (No. 8.) on the cover of the machine, on which an index shews the days of the moon's age.

There are two semicircles (Plate XLVIII. fig. 1.) fixed to an elliptical ring, which being put like a cap upon the earth, and the forked part *F* upon the moon, shews the tides as the earth turns round within them, and they are led round it by the moon. When the different places come to the semicircle *AaEbbB*, they have tides of flood; and when they come to the semicircle *CED*, they have tides of ebb; the index on the hour-circle (No. 7. Plate XLVII.) shewing the times of these phenomena.

There is a jointed wire, of which one end being put into a hole in the upright stem that holds the earth's cap, and the wire laid into a small forked piece which may be occasionally put upon Venus or Mercury, shews the direct and retrograde motions of these two planets, with their stationary times and places, as seen from the earth.

The whole machinery is turned by a winch or handle, (No. 12.), and is so easily moved, that a clock might turn it without any danger of stopping.

To give a plate of the wheel-work of this machine, would answer no purpose, because many of the wheels lie so behind others as to hide them from sight in any view whatever.

The COMETARIUM, (Plate XLVIII. fig. 2.) This curious

Fig. 1.

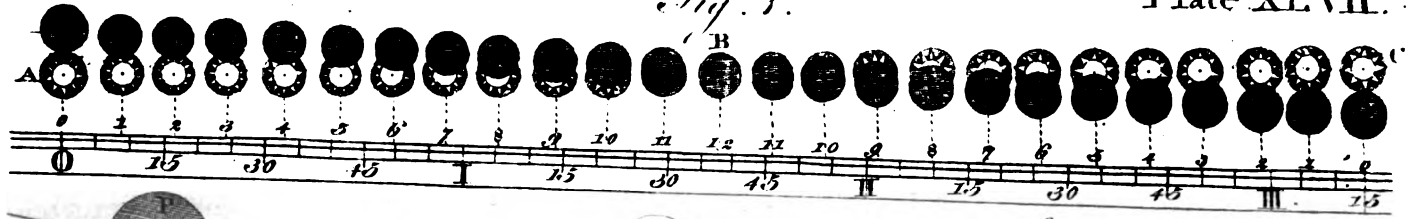


Fig. 2.

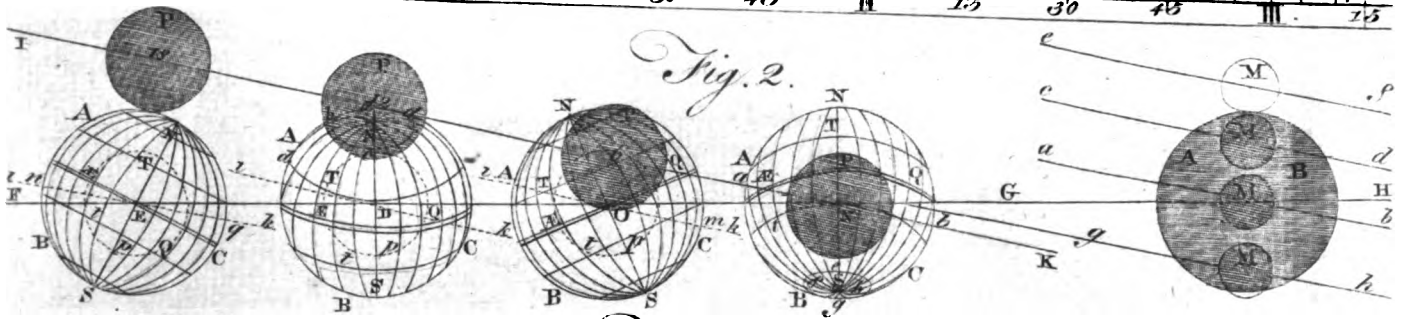


Fig. 3  
FERGUSON'S ORRERY

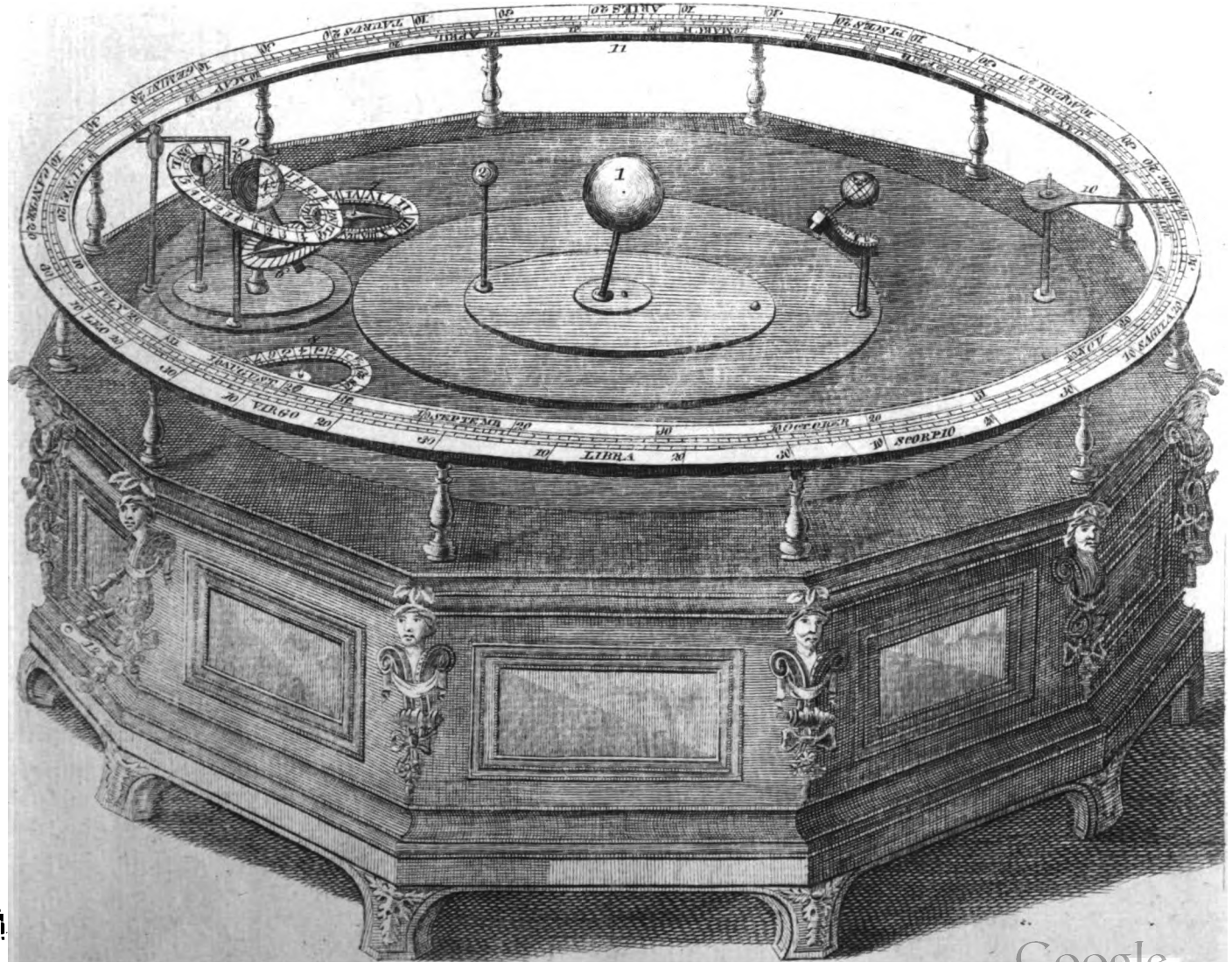






Fig. 1.

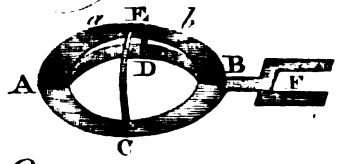


Fig. 2.

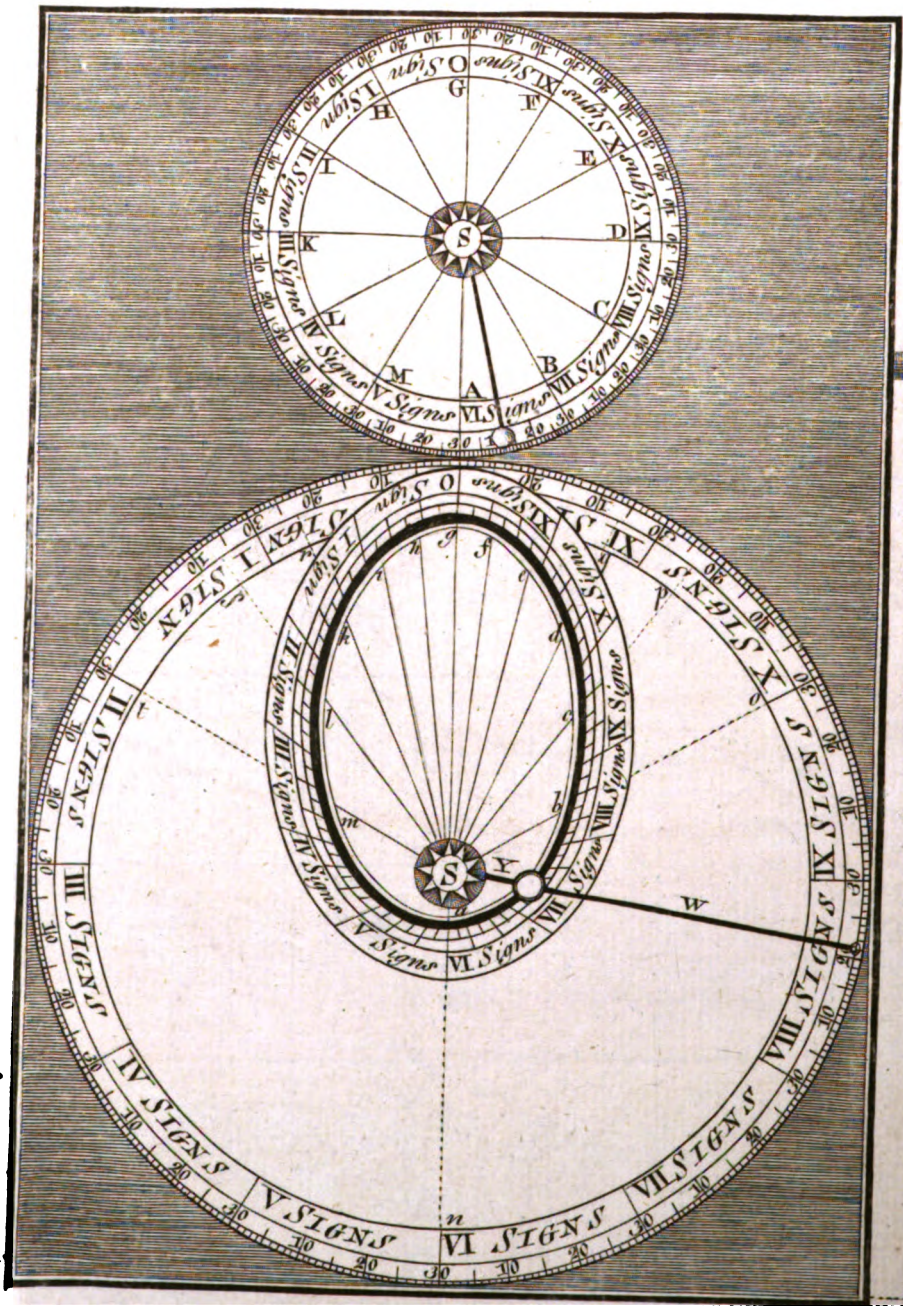
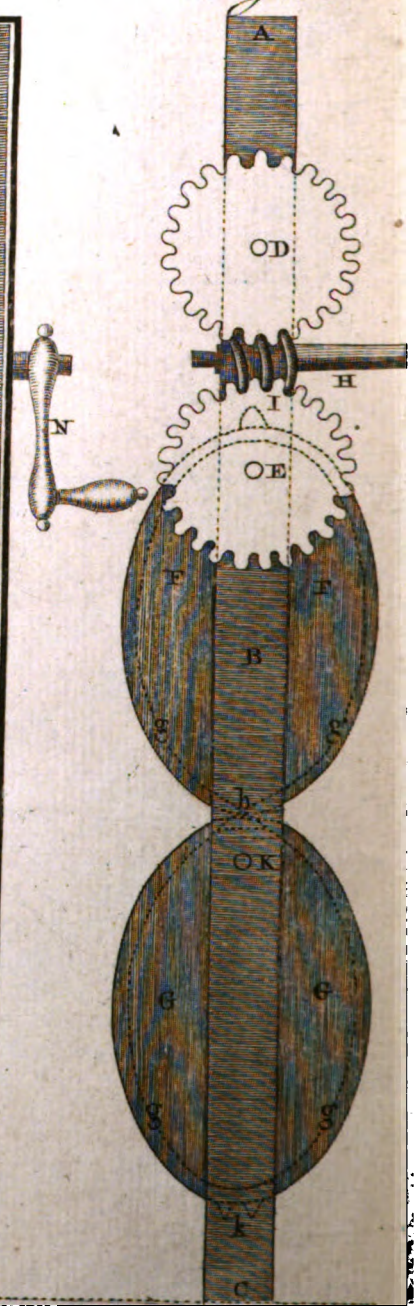


Fig. 3.





curious machine shews the motion of a comet or excentric body moving round the sun, describing equal areas in equal times, and may be so contrived as to shew such a motion for any degree of excentricity. It was invented by the late Dr Defaguliers.

The dark elliptical groove round the letters *abcdefghijklm* is the orbit of the comet *Y*: this comet is carried round in the groove according to the order of letters, by the wire *W* fixed in the sun *S*, and slides on the wire as it approaches nearer to, or recedes farther from the sun, being nearest of all in the perihelion *a*, and farthest in the aphelion *g*. The arcs, *aSb*, *bSc*, *cSd*, &c. or contents of these several triangles, are all equal; and in every turn of the winch *N*, the comet *Y* is carried over one of these areas; consequently, in as much time as it moves from *f* to *g*, or from *g* to *b*, it moves from *m* to *a*, or from *a* to *b*; and so of the rest, being quickest of all at *a*, and slowest at *g*. Thus the comet's velocity in its orbit continually decreases from the perihelion *a* to the aphelion *g*; and increases in the same proportion from *g* to *a*.

The elliptic orbit is divided into 12 equal parts or signs, with their respective degrees, and so is the circle *nopqrstu*, which represents a great circle in the heavens, and to which the comet's motion is referred by a small knob on the point of the wire *W*. Whilst the comet moves from *f* to *g* in its orbit, it appears to move only about five degrees in this circle, as is shewn by the small knob on the end of the wire *W*; but in as short time as the comet moves from *m* to *a*, or from *a* to *b*, and it appears to describe the large space *tn* or *uo* in the heavens, either of which spaces contains 120 degrees, or four signs. Were the excentricity of its orbit greater, the greater still would be the difference of its motion, and *vice versa*.

*ABCDEFGHIKLMA* is a circular orbit for shewing the equable motion of a body round the sun *S*, describing equal areas *ASB*, *BSC*, &c. in equal times with those of the body *Y* in its elliptical orbit above mentioned; but with this difference, that the circular motion describes the equal arcs *AB*, *BC*, &c. in the same equal times that the elliptical motion describes the unequal arcs, *ab*, *bc*, &c.

Now, suppose the two bodies *Y* and *1* to start from the points *a* and *A* at the same moment of time, and, each having gone round its respective orbit, to arrive at these points again at the same instant, the body *Y* will be forwarder in its orbit than the body *1* all the way from *a* to *g*, and from *A* to *G*; but *1* will be forwarder than *Y* through all the other half of the orbit; and the difference is equal to the equation of the body *Y* in its orbit. At the points *aA*, and *gG*, that is, in the perihelion and aphelion, they will be equal; and then the equation vanishes. This shews why the equation of a body moving in an elliptic orbit, is added to the mean or supposed circular motion from the perihelion to the aphelion, and subtracted from the aphelion to the perihelion, in bodies moving round the sun, or from the perigee to the apogee, and from the apogee to the perigee in the moon's motion round the earth.

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- This motion is performed in the following manner by the machine, (Plate XLVIII. fig. 3.). *ABC* is a wooden bar, (in the box containing the wheel-work), above which are the wheels *D* and *E*, and below it the elliptic plates *FF* and *GG*; each plate being fixed on an axis in one of its focuses, at *E* and *K*; and the wheel *E* is fixed on the same axis with the plate *FF*. These plates have grooves round their edges precisely of equal diameters to one another, and in these grooves is the cat-gut string *gg*, *gg* crossing between the plates at *b*. On *H*, the axis of the handle or winch *N* in fig. 2. is an endless screw in fig. 3. working in the wheels *D* and *E*, whose numbers of teeth being equal, and should be equal to the number of lines *aS*, *bS*, *cS*, &c. in fig. 2. they turn round their axes in equal times to one another, and to the motion of the elliptic plates. For, the wheels *D* and *E* having equal numbers of teeth, the plate *FF* being fixed on the same axis with the wheel *E*, and the plate *FF* turning the equally big plate *GG* by a cat-gut string round them both, they must all go round their axes in as many turns of the handle *N* as either of the wheels has teeth.

It is easy to see, that the end *b* of the elliptical plate *FF* being farther from its axis *E* than the opposite end *I* is, must describe a circle so much the larger in proportion, and therefore move through so much more space in the same time; and for that reason the end *b* moves so much faster than the end *I*, although it goes no sooner round the centre *E*. But then the quick-moving end *b* of the plate *FF* leads about the short end *bK* of the plate *GG* with the same velocity; and the slow-moving end *I* of the plate *FF* coming half round as to *B*, must then lead the long end *k* of the plate *GG* as slowly about: so that the elliptical plate *FF* and its axis *E* move uniformly and equally quick in every part of its revolution; but the elliptical plate *GG*, together with its axis *K*, must move very unequally in different parts of its revolution; the difference being always inversely as the distance of any point of the circumference of *GG* from its axis at *K*: or in other words, to instance in two points, if the distance *Kk* be four, five, or six times as great as the distance *Kb*, the point *b* will move in that position four, five, or six times as fast as the point *k* does, when the plate *GG* has gone half round; and so on for any other excentricity or difference of the distances *Kk* and *Kb*. The tooth *I* on the plate *FF* falls in between the two teeth at *k* on the plate *GG*, by which means the revolution of the latter is so adjusted to that of the former, that they can never vary from one another.

On the top of the axis of the equally-moving wheel *D* in fig. 3. is the sun *S* in fig. 2.; which sun, by the wire fixed to it, carries the ball *1* round the circle *ABCD*, &c. with an equable motion, according to the order of the letters: and on the top of the axis *K* of the unequally-moving elliptic *GG*, in fig. 3. is the sun *S* in fig. 2. carrying the ball *Y* unequally round in the elliptical groove *abcd*, &c. *N. B.* This elliptical groove must be precisely equal and similar to the verge of the plate *GG*, which is also equal to that of *FF*.

In this manner machines may be made to shew the

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true

true motion of the moon about the earth, or of any planet about the sun, by making the elliptical plates of the same excentricities, in proportion to the radius, as the orbits of the planets are, whose motions they represent; and so their different equations in different parts of their orbits may be made plain to sight, and clearer ideas of these motions and equations acquired in half an hour, than could be gained from reading half a day about such motions and equations.

The IMPROVED CELESTIAL GLOBE, (Plate XLIV. fig. 2.) On the north pole of the axis, above the hour-circle, is fixed an arch *MKH* of  $23\frac{1}{2}$  degrees; and at the end *H* is fixed an upright pin *HG*, which stands directly over the north pole of the ecliptic, and perpendicular to that part of the surface of the globe. On this pin are two moveable collets at *D* and *H*, to which are fixed the quadrantile wires *N* and *O*, having two little balls on their ends for the sun and moon, as in the figure. The collet *D* is fixed to the circular plate *F*, whereon the  $29\frac{1}{2}$  days of the moon's age are engraven, beginning just under the sun's wire *N*; and as this wire is moved round the globe, the plate *F* turns round with it. These wires are easily turned, if the screw *G* be slackened; and when they are set to their proper places, the screw serves to fix them there so as in turning the ball of the globe, the wires with the sun and moon go round with it; and these two little balls rise and set at the same times, and on the same points of the horizon, for the day to which they are rectified, as the sun and moon do in the heavens.

Because the moon keeps not her course in the ecliptic, (as the sun appears to do), but has a declination of  $5\frac{1}{2}$  degrees on each side from it in every lunation, her ball may be screwed as many degrees to either side of the ecliptic as her latitude or declination from the ecliptic amounts to at any given time; and for this purpose *S*, Plate LI. fig. 2. (*by mistake omitted to be inserted in the proper plate*) is a small piece of pasteboard, of which the curved edge at *S* is to be set upon the globe at right angles to the ecliptic, and the dark line over *S* to stand upright upon it. From this line, on the convex edge, are drawn the  $5\frac{1}{2}$  degrees of the moon's latitude on both sides of the ecliptic; and when this piece is set upright on the globe, its graduated edge reaches to the moon on the wire *O*, by which means she is easily adjusted to her latitude found by an ephemeris.

The horizon is supported by two semicircular arches, because pillars would stop the progress of the balls when they go below the horizon in an oblique sphere.

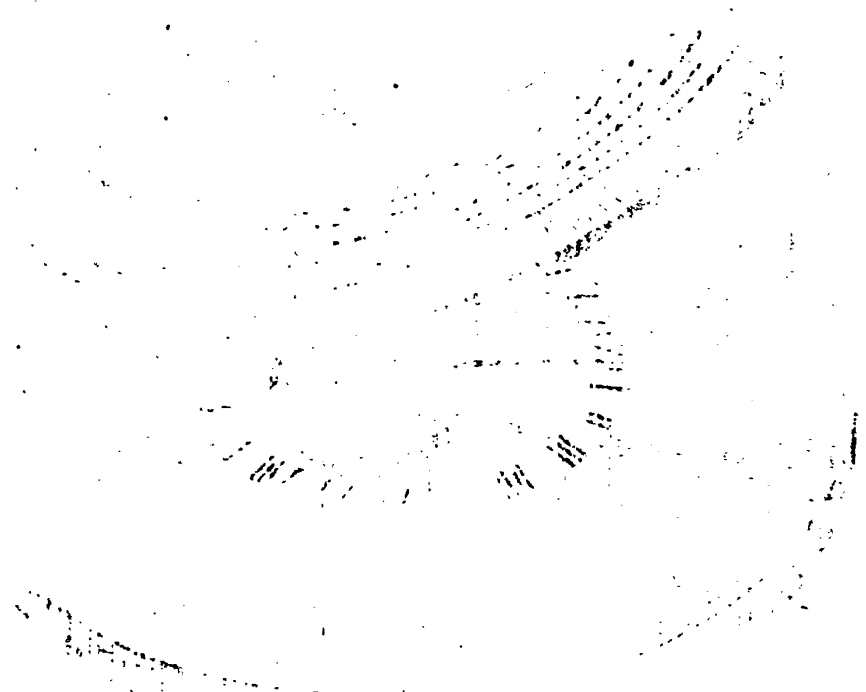
*To rectify this globe.* Elevate the pole to the latitude of the place; then bring the sun's place in the ecliptic for the given day to the brazen meridian, and set the hour-index to XII at noon, that is to the upper XII on the hour-circle; keeping the globe in that situation, slacken the screw *G*, and set the sun directly over his place on the meridian; which done, set the moon's wire under the number that expresses her age for that day on the plate *F*, and she will then stand over her place in the ecliptic, and shew what constellation she is in. Lastly, fasten the screw *G*, and laying the curved edge of the pasteboard *S* over the ecliptic below the moon, adjust the moon to her latitude over the graduated edge of the pasteboard; and the globe will be rectified.

Having thus rectified the globe, turn it round, and observe on what points of the horizon the sun and moon balls rise and set, for these agree with the points of the compass on which the sun and moon rise and set in the heavens on the given day; and the hour-index shews the times of their rising and setting; and likewise the time of the moon's passing over the meridian.

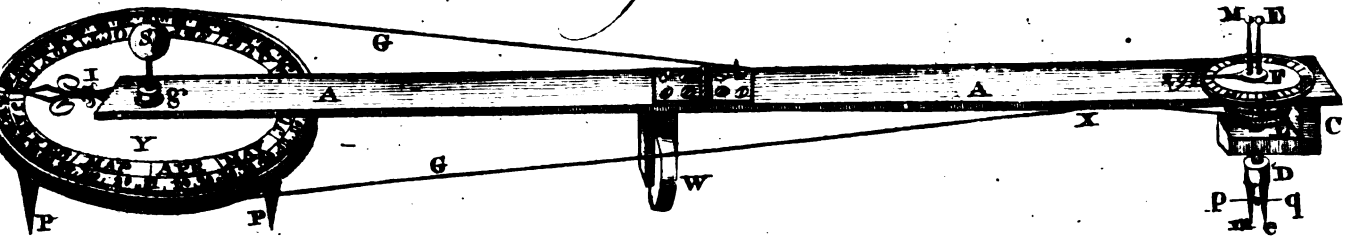
This simple apparatus shews all the varieties that can happen in the rising and setting of the sun and moon; and makes the fore-mentioned phenomena of the harvest-moon plain to the eye. It is also very useful in reading lectures on the globes, because a large company can see this sun and moon go round, rising above and setting below the horizon at different times, according to the seasons of the year; and making their appulses to different fixed stars. But in the usual way, where there is only the places of the sun and moon in the ecliptic to keep the eye upon, they are easily lost sight of, unless they be covered with patches.

The PLANETARY GLOBE, (Plate XLIX. fig. 1.) In this machine, a terrestrial globe is fixed on its axis standing upright on the pedestal *CDE*, on which is an hour-circle, having its index fixed on the axis, which turns somewhat tightly in the pedestal, so that the globe may not be liable to shake; to prevent which, the pedestal is about two inches thick, and the axis goes quite through it, bearing on a shoulder. The globe is hung in a graduated brazen meridian, much in the usual way; and the thin plate *N, NE, E* is a moveable horizon graduated round the outer edge, for shewing the bearings and amplitudes of the sun, moon, and planets. The brazen meridian is grooved round the outer edge; and in this groove is a slender semi-circle of brass, the ends of which are fixed to the the horizon in its north and south points: this semi-circle slides in the groove as the horizon is moved in rectifying it for different latitudes. To the middle of this semi-circle is fixed a pin, which always keeps in the zenith of the horizon, and on this pin the quadrant of altitude *q* turns; the lower end of which, in all positions, touches the horizon as it is moved round the same. This quadrant is divided into 90 degrees from the horizon to the zenithal pin on which it is turned, at 90. The great flat circle or plate *AB* is the ecliptic, on the outer edge of which the signs and degrees are laid down; and every fifth degree is drawn through the rest of the surface of this plate towards its center. On this plate are seven grooves, to which seven little balls are adjusted by sliding wires, so that they are easily moved in the grooves, without danger of starting them. The ball next the terrestrial globe is the moon, the next without it is Mercury, the next Venus, the next the sun, then Mars, then Jupiter, and lastly Saturn. This plate, or ecliptic, is supported by four strong wires, having their lower ends fixed into the pedestal, at *C, D, E*, the fourth being hid by the globe. The ecliptic is inclined  $23\frac{1}{2}$  degrees to the pedestal, and is therefore properly inclined to the axis of the globe which stands upright on the pedestal.

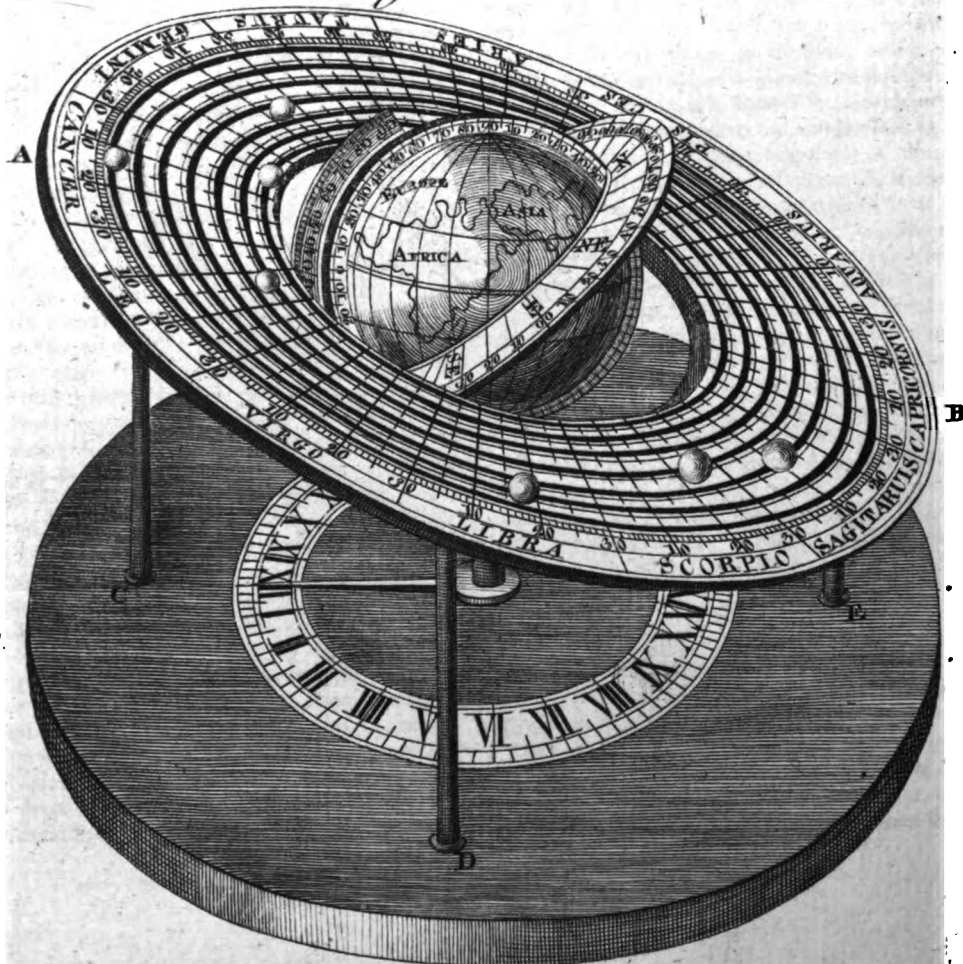
*To rectify this machine.* Set the sun, and all the planetary balls, to their geocentric places in the ecliptic for any given time, by an ephemeris; then set the north point of the



*Fig. 2.*



*Fig. 1.*



the horizon to the latitude of your place on the brazen meridian, and the quadrant of altitude to the fourth point of the horizon; which done, turn the globe with its furniture till the quadrant of altitude comes right against the sun, viz. to his place in the ecliptic; and keeping it there, set the hour-index to the XII next the letter *C*; and the machine will be rectified, not only for the following problems, but for several others which the artist may easily find out.

**PROBLEM I.** *To find the amplitudes, meridian altitudes, and times of rising, culminating, and setting, of the sun, moon, and planets.*

Turn the globe round eastward, or according to the order of signs; and as the eastern edge of the horizon comes right against the sun, moon, or any planet, the hour-index will shew the time of its rising; and the inner edge of the ecliptic will cut its rising amplitude in the horizon. Turn on, and as the quadrant of altitude comes right against the sun, moon or planets, the ecliptic cuts their meridian altitudes in the quadrant, and the hour-index shews the times of their coming to the meridian. Continue turning, and as the western edge of the horizon comes right against the sun, moon, or planets, their setting amplitudes are cut in the horizon by the ecliptic; and the times of their setting are shewn by the index on the hour-circle.

**PROB. II.** *To find the altitude and azimuth of the sun, moon, and planets, at any time of their being above the horizon.*

Turn the globe till the index comes to the given time in the hour-circle, then keep the globe steady, and moving the quadrant of altitude to each planet respectively, the edge of the ecliptic will cut the planet's mean altitude on the quadrant, and the quadrant will cut the planet's azimuth, or point of bearing on the horizon.

**PROB. III.** *The sun's altitude being given at any time either before or after noon, to find the hour of the day, and variation of the compass, in any known latitude.*

With one hand hold the edge of the quadrant right against the sun; and, with the other hand, turn the globe westward, if it be in the forenoon, or eastward if it be in the afternoon, until the sun's place at the inner edge of the ecliptic cuts the quadrant in the sun's observed altitude; and then the hour-index will point out the time of the day, and the quadrant will cut the true azimuth, or bearing of the sun for that time: The difference between which, and the bearing shewn by the azimuth compass, shews the variation of the compass in that place of the earth.

THE **TRAJECTORIUM LUNARE**, Plate XLIX. fig. 2. This machine is for delineating the paths of the earth and moon, shewing what sort of curves they make in the ethereal regions. *S* is the sun, and *E* the earth, whose centres are 81 inches distant from each other; every inch answering to a million of miles. *M* is the moon,

whose centre is  $\frac{24}{100}$  parts of an inch from the earth's in this machine, this being in just proportion to the moon's distance from the earth. *AA* is a bar of wood, to be moved by hand round the axis *g* which is fixed in the wheel *Y*. The circumference of this wheel is to the circumference of the small wheel *L* (below the other end of the bar) as  $365\frac{1}{4}$  days is to  $29\frac{1}{2}$ , or as a year is to a lunation. The wheels are grooved round their edges, and in the grooves is the cat-gut string *GG* crossing between the wheels at *X*. On the axis of the wheel *L* is the index *F*, in which is fixed the moon's axis *M* for carrying her round the earth *E* (fixed on the axis of the wheel *L*) in the time that the index goes round a circle of  $29\frac{1}{2}$  equal parts, which are the days of the moon's age. The wheel *Y* has the months and days of the year all round its limb; and in the bar *AA* is fixed the index *I*, which points out the days of the months answering to the days of the moon's age, shewn by the index *F*, in the circle of  $29\frac{1}{2}$  equal parts at the other end of the bar. On the axis of the wheel *L* is put the piece *D*, below the cock *C*, in which this axis turns round; and in *D* are put the pencils *e* and *m*, directly under the earth *E* and moon *M*; so that *m* is carried round *e*, as *M* is round *E*.

Lay the machine on an even floor, pressing gently on the wheel *Y*, to cause its spiked feet (of which two appear at *P* and *P*, the third being supposed to be hid from sight by the wheel) enter a little into the floor to secure the wheel from turning. Then lay a paper about four feet long under the pencils *e* and *m*, cross-wise to the bar; which done, move the bar slowly round the axis *g* of the wheel *Y*; and as the earth *E* goes round the sun *S*, the moon *M* will go round the earth with a duly proportioned velocity; and the friction-wheel *W* running on the floor, will keep the bar from bearing too heavily on the pencils *e* and *m*, which will delineate the paths of the earth and moon. As the index *I* points out the days of the months, the index *F* shews the moon's age on these days, in the circle of  $29\frac{1}{2}$  equal parts. And as this last index points to the different days in its circle, the like numeral figures may be set to those parts of the curves of the earth's path and moon's, where the pencils *e* and *m* are at those times respectively, to shew the places of the earth and moon. If the pencil *e* be pushed a very little off, as if from the pencil *m*, to about  $\frac{1}{10}$  part of their distance, and the pencil *m* pushed as much towards *e*, to bring them to the same distances again, though not to the same points of space; then, as *m* goes round *e*, *e* will go as it were round the centre of gravity between the earth *e* and moon *m*; but this motion will not sensibly alter the figure of the earth's path or the moon's.

If a pin, as *p*, be put through the pencil *m*, with its head towards that of the pin *q* in the pencil *e*, its head will always keep thereto as *m* goes round *e*, or as the same side of the moon is still obverted to the earth. But the pin *p*, which may be considered as an equatorial diameter of the moon, will turn quite round the point *m*, making all possible angles with the line of its progress, or line of the moon's path. This is an ocular proof of the moon's turning round her axis.

The

The TIDE-DIAL, Plate L. fig. 1. The outside parts of this machine consist of, 1. An eight-sided box, on the top of which at the corners is shewn the phases of the moon at the octants, quarters, and full. Within these is a circle of  $29\frac{1}{2}$  equal parts, which are the days of the moon's age accounted from the sun at new moon, round to the sun again. Within this circle is one of 24 hours divided into their respective halves and quarters. 2. A moving elliptical plate, painted blue, to represent the rising of the tides under and opposite to the moon; and has the words, *high water, tide falling, low water, tide rising*, marked upon it. To one end of this plate is fixed the moon *M* by the wire *W*, and goes along with it. 3. Above this elliptical plate is a round one, with the points of the compass upon it, and also the names of above 200 places in the large machine (but only 32 in the figure, to avoid confusion) set over those points in which the moon bears when she raises the tides to the greatest heights at these places twice in every lunar day: And to the north and south points of this plate are fixed two indexes *I* and *K*, which shew the times of high water, in the hour circle, at all these places. 4. Below the elliptical plate are four small plates, two of which project out from below its ends at new and full moon; and so, by lengthening the ellipse, shew the spring-tides, which are then raised to the greatest heights by the united attractions of the sun and moon. The other two of these small plates appear at low water when the moon is in her quadratures, or at the sides of the elliptic plate, to shew the neap tides; the sun and moon then acting cross-wise to each other. When any two of these small plates appear, the other two are hid; and when the moon is in her octants, they all disappear, their being neither spring nor neap-tides at those times. Within the box are a few wheels for performing these motions by the handle or winch *H*.

Turn the handle until the moon *M* comes to any given day of her age in the circle of  $29\frac{1}{2}$  equal parts, and the moon's wire *W* will cut the time of her coming to the meridian on that day, in the hour circle; the XII under the sun being mid-day, and the opposite XII midnight: Then looking for the name of any given place on the round plate (which makes  $29\frac{1}{2}$  rotations whilst the moon *M* makes only one revolution from the sun to

the sun again) turn the handle till that place comes to the word *high water* under the moon, and the index which falls among the forenoon hours will shew the time of high water at that place in the forenoon of the given day: then turn the plate half round, till the same place comes to the opposite high-water mark, and the index will shew the time of high water in the afternoon at that place. And thus, as all the different places come successively under and opposite to the moon, the indexes shew the times of high water at them in both parts of the day: And, when the same places come to the low-water marks, the indexes shew the times of low water. For about three days before and after the times of new and full moon, the two small plates come out a little way from below the high-water marks on the elliptical plate, to shew that the tides rise still higher about these times: And about the quarters, the other two plates come out a little from under the low-water marks towards the sun, and on the opposite side, shewing that the tides of flood rise not then so high, nor do the tides of ebb fall so low, as at other times.

By pulling the handle a little way outward, it is disengaged from the wheel-work, and then the upper plate may be turned round quickly by hand, so as the moon may be brought to any given day of her age in about a quarter of a minute; and by pushing in the handle, it takes hold of the wheel-work again.

On *AB*, (fig. 2.) the axis of the handle *H*, is an endless screw *C*, which turns the wheel *FED* of 24 teeth round in 24 revolutions of the handle: This wheel turns another *ONG* of 48 teeth, and on its axis is the pinion *PQ* of four leaves, which turns the wheel *LKI* of 59 teeth round in  $29\frac{1}{2}$  turnings or rotations of the wheel *FED*, or in 708 revolutions of the handle, which is the number of hours in a synodical revolution of the moon. The round plate, with the names of places upon it, is fixed on the axis of the wheel *FED*; and the elliptical or tide-plate with the moon fixed to it, is upon the axis of the wheel *LKI*; consequently, the former makes  $29\frac{1}{2}$  revolutions in the time that the latter makes one. The whole wheel *FED*, with the endless screw *C*, and dotted part of the axis of the handle *AB*, together with the dotted part of the wheel *ONG*, lie hid below the large wheel *LKI*.

## A S T

ASTROP-WELLS, in Northamptonshire, were recommended by the physicians Willis and Clever, for the cure of the scurvy, asthma, &c.

ASTROSCOPE, an instrument composed of two canes, having the constellations delineated on their surfaces, whereby the stars may be easily known.

ASTRUM, with chemists, signifies that virtue which accrues to things from their preparation; and among ancient physicians, certain medicines in the figure of round cakes impressed with asterisks.

ASTUR, in ornithology, a synonyme of a species of falco. See FALCO.

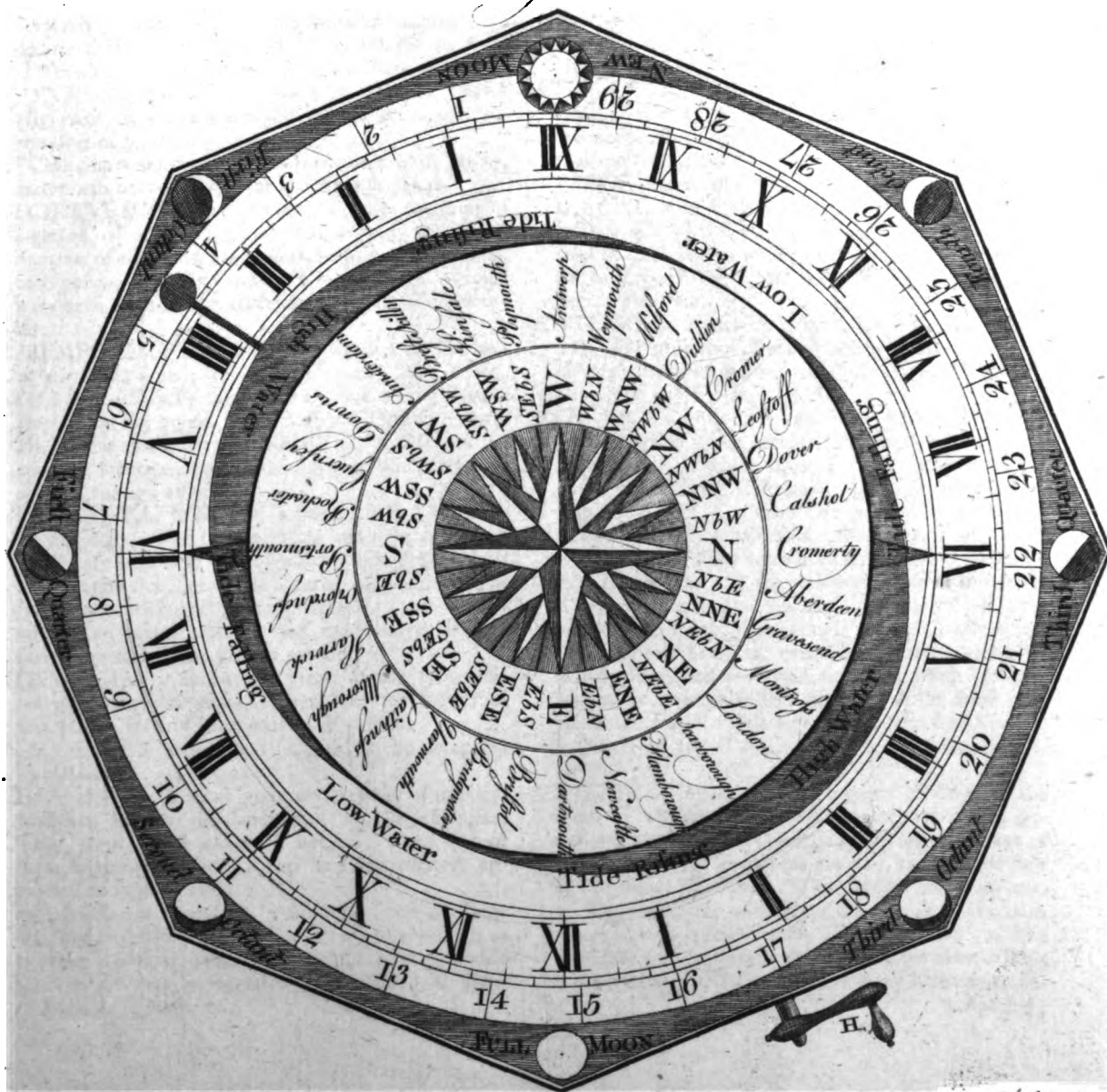
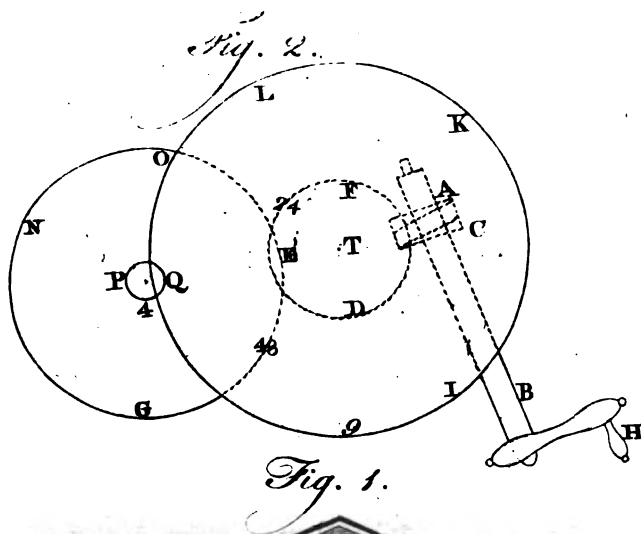
ASTURIA, a maritime province of Spain, lying along

## A S Y

the bay of Biscay, with Galicia on the west, and Biscay on the east. It gives the title of prince to the eldest son of the king of Spain.

ASTYNOMI, in Grecian antiquity, magistrates in Athens, corresponding to the ædiles of the Romans; they were ten in number. See ÆDILE.

ASYLUM, a sanctuary, or place of refuge, where criminals shelter themselves from the hands of justice. The asyls of altars and temples were very ancient; and likewise those of tombs, statues, and other monuments of considerable personages: Thus, the temple of Diana at Ephesus was a refuge for debtors, the tomb of Theseus for slaves. The Jews had their asyls







- Asyla*, the most remarkable of which were, the six cities of refuge, the temple, and the altar of burnt-offerings.
- ASYMMETRY**, the want of proportion between the parts of any thing, being the contrary of symmetry. See **SYMMETRY**.
- ASYMPTOTE**, in geometry, a line which continually approaches nearer to another; but, though continued infinitely, will never meet with it: Of these there are many kinds. In strickness, however, the term *asymptotes* is appropriated to right lines, which approach nearer and nearer to some curves of which they are said to be *asymptotes*; but if they and their curve are indefinitely continued, they will never meet.
- ASYMPTOTIC space**, the same with hyperbolic space. See **HYPERBOLIC**.
- ASYNDETON**, in grammar, a figure which omits the conjunctions in a sentence; as in *veni, vidi, vici*, &c. it is left out.
- ATARAXY**, a term used by the stoics and sceptics, to denote that calmness of mind which secures us from all emotions arising from vanity and self-conceit.
- ATAXY**, in a general sense, the want of order: With physicians, it signifies irregularity of crises and paroxysms of fevers.
- ATCHE**, in commerce, a small silver coin used in Turkey, and worth only one third of the English penny.
- ATCIEVEMENT**, in heraldry, denotes the arms of a person, or family, together with all the exterior ornaments of the shield; as helmet, mantle, crest, scrolls, and motto, together with such quarterings as may have been acquired by alliances, all marshalled in order.
- A TEMPO GIUSTO**, in music, signifies to sing and or play in an equal, true, and just time. See **TIME**.
- ATHAMADULET**, the prime minister of the Persian empire, as the grand vizier is of the Turkish empire. He is great chancellor of the kingdom, president of the council, superintendent of the finances, and is charged with all foreign affairs.
- ATHAMANTA**, in botany, a genus of the pentandria digynia class. The fruit is oblong and streaked. The species are 10, only one of which, *viz.* the libanotis or mountain stone-parsley is a native of Britain. The root of the *athamanta meum* or spignel, a native of Italy, is an useful aromatic and carminative, though little regarded in the present practice.
- ATHANASIA**, in botany, a genus of the syngenesia polygamia æqualis class. There are ten species of this genus, most of them natives of Africa.
- ATHANASIAN creed**, that supposed to be composed by Athanasius. See **CREED**.
- ATHANATI**, in Persian antiquity, a body of cavalry, consisting of ten thousand men, always complete. They were called *athanati*, because, when one of them happened to die, another was immediately appointed to succeed him.
- ATHANOR**, in chemistry, a kind of fixed and large digesting furnace, made with a tower, so contrived as to keep a constant moderate heat for a considerable time, which may be increased or diminished at pleasure.
- sure by shutting the registers. See **CHEMISTRY**, of *furnaces*.
- ATHEIST**, a person who does not believe the existence of a Deity. Many people, both ancient and modern, have pretended to atheism, or have been reckoned atheists by the world; but it is justly questioned whether any man seriously adopted such a principle. These pretensions, therefore, must be founded on pride or affectation.
- ATHELING, ADELING, EDLING, ETHLING, or ETHELING**, among our Saxon ancestors, was a title of honour properly belonging to the heir apparent, or presumptive, to the crown. This honourable appellation was first conferred by king Edward the Confessor on Edgar, to whom he was great uncle, when, being without any issue of his own, he intended to make him his heir.
- ATHENA**, a plaster made of aloes, myrrh, and gum ammoniac, and recommended by some ancient physicians in wounds of the head.
- ATHENÆA**, in Grecian antiquity. See **PANATHENÆA**.
- ATHENÆUM**, in antiquity, a public place wherein the professors of the liberal arts held their assemblies, the rhetoricians declaimed, and the poets rehearsed their performances.
- These places, of which there were a great number at Athens, were built in the manner of amphitheatres, encompassed with seats, called *cunei*. The three most celebrated Athenæa were those at Athens, at Rome, and at Lyons, the second of which was built by the emperor Adrian.
- ATHENREE**, a town of Ireland, in the county of Galway, and province of Connaught, situated about ten miles eastward of the city of Galway, in 8° 50' W. long. and 53° 14' N. lat.
- ATHENS**, anciently the capital of Attica, so famous for its learned men, orators, and captains, now called *Setines*. It stands upon a plain watered by the rivers Illissus and Eridanus, about 40 miles east of the isthmus of Corinth: At present it is said to contain 10,000 inhabitants, three parts of which are Christians. The town does not lie round the castle as anciently, but on the north-west side of it. Here a Greek metropolitan resides. Among the many remains of antiquity, is the temple of Jupiter Olympius, and temple of Minerva, called *Parthenion*, which last is still entire, and converted into a Turkish mosque, which, as later travellers assure us, is the finest temple in the world. This city, as all the rest of Greece, is subject to the Turks. E. long. 24° 15' N. lat. 38° 5'
- ATHERINA**, in ichthyology, a genus of fishes of the order of abdominales. The characters of this genus are these: The upper jaw is plain; the rays of the branchiostege membrane are six; and the side-belt or line shines like silver. The species are two, *viz.*
1. The hepsetus, with about 12 rays in the fin next the anus. It is found in the Mediterranean.
  2. The menidea, with 24 rays in the fin next the anus. This is a very small pellucid fish, with many black points interspersed;

- terspersed; it has many teeth in the lips, but none in the tongue or jaws. It is found in the fresh waters of Carolina, and spawns in April.
- ATHEROMA**, in medicine, a tumour without pain or discolouring of the skin, containing, in a membranaceous bag, matter like pus, intermixed with hard and stony corpuscles, &c.
- ATHERTON**, a town of Warwickshire, situated about ten miles north of Coventry, in  $1^{\circ} 30'$  W. long. and  $52^{\circ} 40'$  N. lat.
- ATHLETÆ**, in antiquity, men of remarkable strength and agility, disciplined to perform in the public games. This was a general term, under which were comprehended wrestlers, boxers, runners, leapers, throwers of the disc, and those who practised in other exercises exhibited in the Olympic, Pythian, and other solemn sports, wherein there were prizes allotted for the conquerors.
- ATHLONE**, a strong town in the county of Westmeath, in the province of Connaught in Ireland, situated on the river Shannon, about 60 miles west of Dublin, in  $8^{\circ} 5'$  W. long. and  $53^{\circ} 20'$  N. lat.
- ATHOL**, a district of Perthshire in Scotland, from whence the ancient and noble family of Murray takes the title of duke.
- ATHOS**, a celebrated mountain, situated in the province of Macedonia, on a peninsula, which stretches into the Ægean sea, near the gulf of Contessa, being an entire chain of mountains extended near seven miles in length, and three in breadth. It is now called Monte Santo, from the 22 monasteries, besides cells and caves, upon it, containing near 6000 monks and hermits; no woman is allowed to come within sight of their convents. It is situated 70 miles east of Salonichi, or Thessalonica, and pays considerable tribute to the Turks, it being under the protection of the *boftangi bascha*; on this chain formerly stood five cities. N. Lat.  $40^{\circ} 10'$  E. long.  $26^{\circ} 20'$ .
- ATHY**, a town of Ireland, in the county of Kildare and province of Leinster, situated on the river Barrow, about 10 miles south of Kildare, in  $7^{\circ} 5'$  W. long. and  $53^{\circ}$  N. lat.
- ATIGNY**, a small town of Champaign in France, situated on the river Aisne, about 20 miles south of Rheims, in  $4^{\circ} 40'$  E. long. and  $49^{\circ} 25'$  N. lat.
- ATINGUACU**, in ornithology. See *CUCULUS*.
- ATLANTIC OCEAN**, that bounded by Europe and Africa on the east, and by America on the west.
- ATLANTIDES**, in astronomy. See *PLEIADES*.
- ATLAS** the name of a ridge of mountains, running from east to west through the north of Africa, from whence the Atlantic Ocean took its name.
- ATLAS**, in architecture, the same with *telamon*. See *TELAMON*.
- ATLAS**, in anatomy, the name by which some call the first vertebra of the neck; so called in allusion to Mount Atlas. See p. 167.
- ATLAS**, in matters of literature, denotes a book of universal geography, containing maps of all the known parts of the world.
- ATMOSPHERE**, the vast collection of air which surrounds the earth for a great height. For the height and other properties of the atmosphere, see *PNEUMATICS*.
- ATOM**, in philosophy, a particle of matter, so minute as to admit of no division. Atoms are the *minima natura*, and are conceived as the first principles or component parts of all physical magnitude. See *CHEMISTRY*.
- ATOMICAL philosophy**, or the doctrine of atoms, a system which, from the hypothesis that atoms are endued with gravity and motion, accounted for the origin and formation of things. This philosophy was first broached by Moichus, some time before the Trojan war; but was much cultivated and improved by Epicurus, whence it is denominated the Epicurean philosophy. See *EPICUREAN*.
- ATONICS**, in grammar, words not accented. See *ACCENT*.
- ATONY**, in medicine, a defect of tone or tension, or a laxity or debility of the solids of the body.
- ATRA BILIS**, black bile, one of the humours of the ancient physicians; which the moderns call melancholy.
- ATRACTYLIS**, in botany, a genus of the syngenesia polygamia æqualis class. The corolla is radiated, and each corolla of the radius has five teeth. The species are three, none of which are natives of Britain.
- ATRAGENE**, in botany, a genus of the polyandria polygynia class. The calix has four leaves; the petals are 12; and the seeds are caudated. There are three species, all natives of the east.
- ATRAPHAXIS**, in botany, a genus of the hexandria digynia class. The calix has two leaves; the petals are two, and sinuated; and there is but one seed. There are two species; viz. the spinosa, a native of Media; and the undulata, a native of Æthiopia.
- ATRÆTI**, in medicine, infants having no perforation in the anus, or persons imperforated in the vagina or urethra.
- ATRI**, a town of the Farther Abruzzo, in the kingdom of Naples, situated in  $15^{\circ} 20'$  E. long. and  $42^{\circ} 40'$  N. lat.
- ATRICAPILLA**, in ornithology, a trivial name of a species of muscicapa; and also of a species of motacilla. See *MUSCICAPA*, and *MOTACILLA*.
- ATRICES**, or *ATTRICES*, in medicine, tubercles about the anus, reckoned a kind of condylomata.
- ATRICI**, in surgery, small sinuses in the extremity of the intestinum rectum, which do not perforate into its cavity.
- ATRIPLEX**, in botany, a genus of the polygamia monœcia class. The calix of the hermaphrodite flower has five leaves; it has no corolla; the stamina are five, and the stylus is divided into two parts; there is but one depressed seed. The calix of the female flower has two leaves; it has no corolla nor stamina; the stylus is divided into two parts; and there is but one depressed seed. The species are 12, of which eight are natives of Britain; viz. the portulacoides, or sea-purslain; the lacineata, or jagged sea-orache; the hastata, or spear-leaved orache; the erecta, or wild orache; the patula, or narrow-leaved orache; the serrata, or indented

indented sea-orache; the littoralis, or grass-leaved orache; and the pedunculata, or stalked sea-orache.

**ATROPA**, in botany, a genus of the pentandria monogynia class. The corolla is shaped like a bell; the stamina are distant; the berry is globular, and consists of two cells or apartments. The species are five; viz. 1. The mandragora, or mandrake, a native of Spain and the East. The mandrake is divided into male and female. The male mandrake has a very large, long, and thick root; it is largest at the top or head, and from thence gradually grows smaller. Sometimes it is single and undivided to the bottom: but more frequently it is divided into two, sometimes into three, or more parts. From this root there arise a number of very long leaves, broadest in the middle, narrow towards the base, and obtusely pointed at the end; they are of a foot or more in length, and five inches or thereabouts in breadth; they are of a dusky and disagreeable green colour, and of a very foetid smell. The female mandrake perfectly resembles the other in its manner of growth: but the leaves are longer and narrower, and of a darker colour, as are also the seeds and roots. Authors have spoken very largely and idly of the virtues of this plant. The most common quality attributed to it, is that of rendering barren women fruitful: but we have no tolerable foundation for this: what we certainly know of it is, that it has a soporific virtue like that of opium; and the bark in small doses, Herman assures us, has often been known to do great service in hysterical complaints; but it should be used sparingly, otherwise it will often bring on convulsions, and many other mischievous symptoms. The ancients used it when they wanted a narcotic of the most powerful kind. 2. The balladonia, or deadly night-shade, a native of Britain: the berries are poisonous. 3. The physalodes, a native of Peru. 4. The frutescens, a native of Spain; and, 5. The arborescens, a native of America.

**ATROPHY**, in medicine, a disease, wherein the body, or some of its parts, do not receive the necessary nutriment, but waste and decay incessantly. See **MEDICINE**.

**ATTACHING**, or **ATTACHMENT**, in English law, the taking or apprehending of a person, by virtue of a writ or precept.

**ATTACHMENT out of the Chancery**, is obtained upon an affidavit made, that the defendant was served with a subpoena, and made no appearance; or it issueth upon not performing some order or decree.

**ATTACHMENT out of the Forest**, is one of the three courts held in the Forest. The lowest court is called the court of Attachment, or wood mote court; the mean, *swan mote*; and the highest, the *justice in eyre's seat*. This attachment is by three means, by goods and chattels, by body, pledges, and mainprize, or the body only. This court is held every forty days throughout the year, whence it is called the *forty-days court*.

**ATTACHMENT of privilege**, is by virtue of a man's privilege to call another to that court whereto he him-

self belongs, and in respect whereof he is privileged to answer some action.

**ATTACHMENT bonorum**, in the old English statute books, imports a distress taken upon the goods or chattels of a person sued for a personal estate, or debt, by the legal attachiators, or bailiffs, as a security to answer the action.

**ATTAINDER**, in Scots law. See **TREASON**.

**ATTAINT**, in law, a writ which lies against a jury that have given a false verdict in any court of record, in a real or personal action, where the debt or damages amount to above forty shillings.

**ATTAINT**, among farriers, a knock or hurt in a horse's leg, proceeding either from a blow with another horse's foot, or from an over-reach in frosty weather, when a horse being rough-shod, or having shoes with long calkers, strikes his hinder feet against his fore-leg.

**ATTAINTED**, in law, is applied to a person's being found guilty of any crime or offence, especially treason or felony, by due course of law.

**ATTELABUS**, in zoology, a genus of insects belonging to the order of coleoptera or beetle-kind. It has four wings, of which the superior is crustaceous, and serve as a sheath or cover to the inferior, which are membranous. The head tapers behind, and is inclined; the feelers turn thicker toward the apex. The species are 13; viz. 1. The coryli is black, with red elytra or crustaceous wings. 2. The avellanæ is black, with the breast, feet, and elytra red. 3. The curculionoides is black, with red elytra and breast. The above three species frequent the leaves of the hazel and filbert nut-trees. 4. The surinamenfis has a double indentation (or two teeth) in the top of the elytra. It is a native of Surinam. 5. The pensilvanicus is black, with red elytra, a black belt round the middle, and another towards the apex of the elytra. It is a native of Philadelphia. 6. The melanurus is black, with testaceous elytra black at the apex. It is a native of Sweden. 7. The betulæ has saltatory or springy legs, and the whole body is of a dark-red colour. It frequents the leaves of the birch-tree. 8. The formicarius is black, with red elytra, and a double white belt toward the base. It is a native of Europe. 9. The sipylus is green, with a hairy breast, and a double yellow belt upon the elytra. 10. The apiarius is bluish, with red elytra, and three black belts. It is a native of Germany. 11. The mollis is yellowish and hairy, with pale elytra, and three belts. It is a native of Europe. 12. The ceramboides is of a blackish-red colour, and the elytra is furrowed. It frequents the spongy boletus, a species of mushroom. 13. The buprestoides is of a dark-red colour, with a globular breast, and nervous elytra. It is a native of Europe.

**ATTENUANTS**, medicines which resolve the viscosity of the humours; thereby promoting their circulation, as well as the discharge of all noxious or excrementitious matter.

**ATTESTATION**, the act of affirming or witnessing the truth of something, more especially in writing.

**ATTIC**.

**ATTIC**, any thing relating to Attica, or to the city of Athens: thus Attic salt, in philology, is a delicate poignant sort of wit and humour peculiar to the Athenian writers; Attic witness, a witness incapable of corruption, &c.

**ATTIC**, in architecture, a sort of building wherein the roof or covering is not to be seen. thus named, because the buildings at Athens were generally of this form.

**ATTIC order**, a small order raised upon a large one, by way of crowning, or to finish the building; or it is, according to some, a kind of rich pedestal, sometimes used for the conveniency of having a wardrobe, or the like; and instead of columns, has only pilasters of a particular form, and sometimes no pilasters at all.

The name Attic is also given to a whole story into which this order enters; this little order being always found over another greater one.

**ATTIC base**, a peculiar kind of base used by the ancient architects in the Ionic order; and by Palladio, and some others, in the Doric.

**ATTIRE**, in botany. See **ANTHERÆ**.

**ATTIRE**, in hunting, signifies the head or horns of a deer. The attire of a stag, if perfect, consists of bur, pearls, beam, gutters, antler, sur-antler, royal, fur-royal, and croches; of a buck, of the bur, beam, brow-antler, advancer, palm, and spellers.

**ATTITUDE**, in painting and sculpture, the gesture of a figure or statue; or it is such a disposition of their parts as serves to express the action and sentiments of the person represented.

**ATTLEBURY**, a market-town of Norfolk, about eighty miles north-east of London, situated in 40' E. long. and 52° 30' N. lat.

**ATTOCK**, a city on the eastern frontiers of Persia, capital of a province of the same name, and situated on the river Attock, in 72° E. long. and 33° N. lat.

**ATTOLLENS**, in anatomy, an appellation given to several muscles, otherwise called *levator*es and *elevatores*.

**ATTORNEY**, a person who by consent, commandment, or request, takes heed, sees, and takes upon him the charge of other mens business, in their absence. Attorney is either general or special: Attorney-general is he that by general authority is appointed to all our affairs or suits; as the attorney-general of the king, which is nearly the same with procurator Cæsaris in the Roman empire. Attorneys-general are made either by the king's letters-patent, or by our appointment before justices in eyre, in open court. Attorney special or particular, is he that is employed in one or more causes particularly specified. There are also, in respect of the divers courts, attorneys at large, and attorneys special, belonging to this or that court only.

Attorneys in common law, are nearly the same with proctors in the civil law, and solicitors in courts of equity. Attorneys sue out writs of process, or commence, carry on, and defend actions, or other proceedings, in the names of other persons, in the courts of common law. None are admitted to act without

having served a clerkship for five years, taking the proper oath, being enrolled, and examined by the judges. The attorney-general pleads within the bar. To him come warrants for making out patents, pardons, &c. and he is the principal manager of all law-affairs of the crown.

*Letter of ATTORNEY.* See **LETTER**.

*Warrant of ATTORNEY.* See **WARRANT**.

**ATTOURNMENT**, or **ATTORNTMENT**, in law, a transfer from one lord to another of the homage and service a tenant makes; or that acknowledgment of duty to a new lord.

**ATTRACTION**, in natural philosophy, an indefinite term, applicable to all actions whereby bodies tend towards one another, whether in virtue of their weight, magnetism, electricity, impulse, or any other latent power. See **MECHANICS**, **ELECTRICITY**, &c.

*Elective ATTRACTIONS.* See **CHEMISTRY**.

**ATTRIBUTE**, in a general sense, that which agrees with some person or thing; or a quality determining something to be after a certain manner. Thus, understanding is an attribute of mind, and extension an attribute of body. That attribute which the mind conceives as the foundation of all the rest, is called its essential attribute: thus extension is by some, and solidity by others, esteemed the essential attributes of body or matter.

**ATTRIBUTES**, in theology, the several qualities or perfections of the Divine nature, as wisdom, power, justice, goodness, &c.

**ATTRIBUTES**, in logic, are the predicates of any subject, or what may be affirmed or denied of any thing.

**ATTRIBUTES**, in painting and sculpture, are symbols added to several figures, to intimate their particular office and character. Thus, the eagle is an attribute of Jupiter; a peacock, of Juno; a caduce, of Mercury; a club, of Hercules; and a palm, of Victory.

**ATTRITION**, the rubbing or striking of bodies one against another, so as to throw off some of their superficial particles.

**AVA**, a kingdom of India, beyond the Ganges, situated on the north east part of the bay of Bengal, between the countries of Arracan on the north, and Pegu on the south.

**AVALON**, a town of Burgundy in France, situated in 3° 50' E. long. and 47° 25' N. lat.

**AVARIA**, in the customs of Turkey and Persia, money exacted from Christians or Europeans, to be quit of some false accusation formed on purpose.

**AVAST**, in the sea-language, a term requiring to stop, or to stay.

**AVAUNCHERS**, among hunters, the second branches of a deer's horns. See **HEAD**.

**AUBAGNE**, a town of Provence in France, situated about seven miles southward of Marcellis, in 5° 30' E. long. 43° 15' N. lat.

**AUBANE**, in the customs of France, a right vested in the king of being heir to a foreigner that dies within his dominions.

By this right the French king claims the inheritance of all foreigners that die within his dominions, notwithstanding

withstanding of any testament the deceased could make. An ambassador is not subject to the right of aubane; and the Switz, Savoyards, Scots, and Portuguese, are also exempted, being deemed natives and regnicoles.

**AUBE**, a river of France, which, arising in the south-east part of Champagne, runs north-west, and falls into the Seine below Plancy.

**AUBIGNE**, a town of France, in the province of Berry, and government of Orleans, situated in  $2^{\circ} 20'$  E. long. and  $47^{\circ} 3'$  N. lat.

**AUBIN**, or *St AUBIN*, a town of Brittany in France; its W. long. being  $1^{\circ} 30'$ , and N. lat.  $48^{\circ} 15'$ .

**AUBIN**, in horsemanship, a broken kind of gate, between an amble and a gallop, accounted a defect.

**AUBURN**, a market-town in Wilthshire, situated about 24 miles west of Reading, in  $1^{\circ} 40'$  W. long. and  $51^{\circ} 30'$  N. lat.

**AUBUSSON**, a town a France, in the province of Marche, and government of Lyonois: E. long.  $2^{\circ} 15'$ , and N. lat.  $45^{\circ} 55'$ .

**AUCTION**, a kind of public sale, very much in use for household-goods, books, plate, &c. By this method of sale the highest bidder is always the buyer. This was originally a kind of sale among the ancient Romans, performed by the public crier *sub hasta*, i. e. under a spear stuck up on that occasion, and by some magistrate, who made good the sale by delivery of the goods.

**AUCTION by inch of candle.** See **CANDLE**.

**AUDE**, a river of France, which, taking its rise in the Pyrenees, runs northwards by Alet and Carcaffone; and from thence turning eastward through Languedoc, falls into the Mediterranean, a little to the north-east of Narbonne.

**AUDIANISM**, the same with anthropomorphism. See **ANTHROPOMORPHITES**.

**AUDIENCE**, given to ambassadors, ceremonies observed in courts, at the admission of ambassadors, or public ministers, to a hearing.

In England, audience is given to ambassadors in the presence-chamber; to envoys and residents, in a gallery, closet, or in any place where the king happens to be. Upon being admitted, as is the custom of all courts, they make three bows, after which they cover and sit down; but not before the king is covered and sat down, and has given them the sign to put on their hats.

When the king does not care to have them covered, and sit, he himself stands uncovered; which is taken as a slight.

At Constantinople, ministers usually have audience of the prime vizier.

**AUDIENCE-court**, a court belonging to the archbishop of Canterbury, of equal authority with the arches-court, though inferior both in dignity and antiquity. The original of this court was, because the archbishop of Canterbury heard several causes extrajudicially at home in his own palace; in which, before he would finally determine any thing, he usually committed them to be discussed by men learned in the civil and canon laws, whom, thereupon, he called his auditors;

and so in time it became the power of the man who is called *causarum negotiorumque audentia Cantuariensis auditor, seu officialis*.

**Chamber of AUDIENCE.** See **CHAMBER**.

**AUDIT**, a regular hearing and examination of an account by some proper officers, appointed for that purpose.

**AUDITOR**, in a general sense, a hearer, or one who listens and attends to any thing.

**AUDITOR**, according to our law, is an officer of the king, or some other great person, who, by examining yearly the accounts of the under-officers, makes up a general book, with the difference between their receipts and charges, and their allowances to allocations.

**AUDITOR of the receipts**, is an officer of the exchequer who files the tellers bills, makes an entry of them, and gives the lord-treasurer a certificate of the money received the week before. He also makes debentures to every teller, before they receive any money, and take their accounts. He keeps the black book of receipts, and the treasurer's key of the treasury, and sees every teller's money locked up in the new treasury.

**AUDITORS of the revenue**, or of the exchequer, officers who take the accounts of those who collect the revenues and taxes raised by parliament, and take the accounts of the sheriffs, escheators, collectors, tenants, and customers, and set them down in a book, and perfect them.

**AUDITORS of the prest and imprest**, are officers of the exchequer, who take and make up the accounts of Ireland, Berwick, the mint, and of any money impressed to any man for the king's service.

**AUDITORS collegiate, conventual, &c.** officers formerly appointed in colleges, &c. to examine and pass their accounts.

**AUDITORY nerves**, in anatomy. See p. 249.

**AVAIL of marriage**, in Scots law, that casualty in ward-holding, by which the superior was intitled to a certain sum from his vassal, upon his attaining the age of puberty, as the value or avail of his tocher. See **SCOTS LAW**, tit. *Of casualties due to the superior*.

**AVEIN**, a town in the duchy of Luxemburg, remarkable for a victory which the French obtained over the Spaniards in 1635.

**AVELLANA**, in botany. See **CORYLUS**.

**AVELLANA purgatrix**, a name sometimes given to the fruit of the ricinus. See **RICINUS**.

**AVELLANE**, in heraldry, a cross, the quarters of which somewhat resemble a filbert-nut. Sylvanus Morgan says, that it is the cross which ensigns the mound of authority, or the sovereign's globe.

**AVELLINO**, a town of the kingdom of Naples, and province of Principata, situated about 25 miles east of the city of Naples, in  $15^{\circ} 20'$  E. long. and  $41^{\circ}$  N. lat.

**AVE-MARIA**, the angel Gabriel's salutation of the the Virgin Mary, when he brought her the tidings of the incarnation.—It is become a prayer or form of devotion in the Romish church. Their chaplets and rosaries are divided into so many ave-maries, and so

many pater-nosters, to which the papists ascribe a wonderful efficacy.

**AVENA**, oats, in botany, a genus of the triandria digynia class. The calix has a double valve; and the awn on the back is contorted. The species are 13, six of them natives of Britain; viz. 1. The nuda, or naked oats. 2. The fatua or bearded oat-grafs. 3. The pratensis, or meadow oat-grafs. 4. The pubescens, or rough oat-grafs. 5. The elatior, or tall oat-grafs. 6. The flavescens, or yellow oat-grafs. It is remarkable, that the native place of the fativa, or common oat, cultivated in our fields, is almost totally unknown. Anson says, that he observed it growing wild or spontaneously in the island of Juan Fernandez. But a vague observation from an author of that kind is not to be depended on.

**AVENACEOUS**, something belonging to, or partaking of the nature of oats.

**AVENAGE**, in law, a certain quantity of oats paid by a tenant to a landlord, instead of rent, or some other duties.

**AVENOR**, an officer belonging to the king's stables, who provides oats for the horses. He acts by warrant from the master of the horse.

**AVENS**, in botany. See **CARYOPHILLUS**.

**AVENTURE**, in law books, means a mischance, causing the death of a person without felony.

**AVENUE**, in gardening, a walk planted on each side with trees, and leading to an house, garden-gate, wood, &c. and generally terminated by some distant object. See **GARDENING**.

**AVERAGE**, in commerce, signifies the accidents and misfortunes which happen to ships and their cargoes, from the time of their loading and sailing to their return and unloading; and is divided into three kinds.

1. The simple or particular average, which consists in the extraordinary expences incurred for the ship alone, or for the merchandizes alone. Such is the loss of anchors, masts, and rigging, occasioned by the common accidents at sea; the damages which happen to merchants by storm, prize, shipwreck, wet, or rotting; all which must be born and paid by the thing which suffered the damage.
2. The large and common average, being those expences incurred, and damages sustained, for the common good and security both of the merchandizes and vessels, consequently to be borne by the ship and cargo, and to be regulated upon the whole. Of this number are the goods or money given for the ransom of the ship and cargo, things thrown overboard for the safety of the ship, the expences of unloading for entering into a river or harbour, and the provisions and hire of the sailors when the ship is put under an embargo.
3. The small averages, which are the expences for towing and piloting the ship out of, or into harbours, creeks, or rivers, one third of which must be charged to the ship, and two thirds to the cargo.

Average is more particularly used for a certain contribution that merchants make proportionably to their losses. It also signifies a small duty which those merchants, who send goods in another man's ship, pay to the master for his care of them over and above the

freight. Hence it is expressed in the bills of lading, paying so much freight for the said goods, with primage and average accustomed.

**AVERANCE**, or **AURANCHE**, a sea-port town in Normandy, in France, situated in 1° 20' W. long. and 48° 40' N. lat.

**AVER-CORN**, that conveyed to the lord's granary by his tenants.

**AVERDUPUIS**, or **AVOIRDUPUIS-WEIGHT**, a sort of weight used in England, the pound whereof is made up of sixteen ounces. See **WEIGHT**.

This is the weight for the larger and coarser commodities, such as groceries, cheese, wool, lead, &c. Bakers, who live not in corporation-towns, are to make their bread by avoirdupois-weight, those in corporations by troy weight. Apothecaries buy by avoirdupois-weight, but sell by troy. The proportion of a pound avoirdupois to a pound troy is as 17 to 14.

**AVERIA**, in a general sense, signifies any cattle, but is used in law for oxen, or horses of the plough.

*Replegiare de AVERIIS*. See **REPLEGIARE**.

**AVERNI**, among ancient naturalists, certain lakes, grottoes, and other places, which infect the air with poisonous steams or vapours, called also *mephitæ*.

**AVERRHOA**, in botany, a genus of the decandria pentagynia class. The calix has five leaves; the petals are five, open at top; and the apple or fruit is pentagonal, and divided into five cells. The species are three, all natives of India.

**AVERHOISTS**, the followers of Averhoes, a celebrated commentator of Aristotle, who denied the natural immortality of the soul, and yet pretended to acquiesce in the Christian doctrine concerning it.

**AVERRUNCI**, in the ancient heathen theology, an order of deities among the Romans, whose peculiar office it was to avert danger and exile. Apollo and Hercules are supposed to be of this order.

**AVERSA**, a town of Naples, in the province of Lavoro, situated about 17 miles south of Capua, in 14° 45' E. long. and 41° 15' N. lat.

**AVES**, some small islands, belonging to the Dutch, on the coast of Terra Firma, in South America.

**AVESNES**, a little fortified town of Hainault, in the French Netherlands; situated about 21 miles south of Mons, in 3° 40' E. long. and 50° 10' N. lat.

**AUGMENT**, in grammar, an accident of certain tenses of Greek verbs, being either the prefixing of a syllable, or an increase of the quantity of the initial vowels.

**AUGMENTS**, in mathematics. See **FLUCTIONS**.

**AUGMENTATION**, in a general sense, is the act of adding or joining something to another with a design to render it large.

**AUGMENTATION** is also used for the additament or thing added.

**AUGMENTATION** was also the name of a court erected 27 Hen. VIII. so called from the augmentation of the revenues of the crown, by the suppression of religious houses; and the office still remains, wherein there are many curious records, tho' the court has been dissolved long since.

**AUGMENTATION**, in heraldry, are additional charges

to a coat-armour, frequently given as particular marks of honour, and generally borne either in the escutcheon or a conton; as have all the baronets of England, who have borne the arms of the Province of Ulster in Ireland.

**AUGRE**, or **AWGRE**, an instrument used by carpenters and joiners to bore large round holes; and consisting of a wooden handle, and an iron blade terminated at bottom with a steel bit.

**AUGSBURGH**, a considerable city of Swabia, in Germany; situated in  $11^{\circ}$  E. long. and  $48^{\circ} 20'$  N. lat. It is an imperial city, and remarkable for being the place where the Lutherans presented their confession of faith to the emperor Charles V. at a diet of the empire held in 1550, from hence denominated the *Augsburg confession*.

**AUGUR**, an officer among the Romans appointed to foretell future events, by the chattering and feeding of birds. There was a college or community of them, consisting originally of three members with respect to the three Luceres, Rhamneses, and Tatienses: afterwards the number was increased to nine, four of whom were patricians and five plebeians. They bore an augural staff or wand, as the ensign of their authority; and their dignity was so much respected, that they were never deposed, nor any substituted in their place, though they should be convicted of the most enormous crimes. See **AUGURY**.

**AUGURY**, in antiquity, a species of divination, or the art of foretelling future events, is distinguished into five sorts. 1. Augury from the heavens. 2. From birds. 3. From chickens. 4. From quadrupeds. 5. From portentuous events. When an augury was taken, the augur divided the heavens into four parts, and having sacrificed to the gods, he observed, with great attention, from what part the sign from heaven appeared. If, for instance, there happened a clap of thunder from the left, it was taken as a good omen. If a flock of birds came about a man, it was a favourable presage; but the flight of vultures was unlucky. If, when corn was sown before the sacred chickens, they crowded about it, and eat it greedily, it was looked upon as a favourable omen; but if they refused to eat and drink, it was an unlucky sign. See the article **DIVINATION**.

**AUGUST**, in chronology, the eighth month of our year, containing thirty-one days. August was dedicated to the honour of Augustus Cæsar, because, in the same month, he was created consul, thrice triumphed in Rome, subdued Egypt to the Roman empire, and made an end of civil wars; being before called *Sexatilis*, or the sixth from March.

**AUGUSTA**, or **AUSTA**, an island in the gulph of Venice, on the coast of Damaltia; situated in  $17^{\circ} 40'$  E. long. and  $42^{\circ} 35'$  N. lat.

**AUGUSTBURG**, a city of Germany, in upper Saxony, upon the river Chop, six leagues south of Dresden.

**AUGUSTALES**, in Roman antiquity, an epithet given to the flamens or priests appointed to sacrifice to Augustus after his deification; and also to the ludi or games celebrated in honour of the same prince on the fourth of the ides of October.

**AUGUSTALIA**, a festival instituted by the Romans in honour of Augustus Cæsar, on his return to Rome, after having settled peace in Sicily, Greece, Syria, Asia, and Parthia; on which occasion they likewise built an altar to him, inscribed *Fortune reduci*.

**AUGUSTALIS Præfektus**, a title peculiar to a Roman magistrate who governed Egypt, with a power much like that of a proconsul in other provinces.

**AUGUSTINE**, or *St. AUGUSTINE*, the capital town of Spanish Florida in North America; situated near the frontiers of Georgia, in  $81^{\circ}$  W. long. and  $30^{\circ}$  N. lat.

**CAPE-AUGUSTIN**, a cape of Brazil, in South America; lying in  $35^{\circ}$  W. long. and  $8^{\circ} 30'$  S. lat.

**AUGUSTINS**, a religious order in the church of Rome, who follow the rule of St. Augustin, prescribed them by pope Alexander IV. Among other things, this rule enjoins to have all things in common, to receive nothing without the leave of their superior; and several other precepts relating to charity, modesty, and chastity. There are likewise nuns of this order.

The Augustins are clothed in black, and at Paris are known under the name of the *Religious of St. Genevieve*, that abbey being the chief of the order.

**AUGUSTINUS**, the name of Jansenius's treatise, from which are collected the five famous propositions enumerated under the article Jansenism. See **JANSENISM**.

**AVIARY**, a place set apart for feeding and propagating birds. It should be so large, as to give the birds some freedom of flight; and turfed, to avoid the appearance of foulness on the floor.

**AVICIENNA**, in botany. See **BONITIA**.

**AVIGLIANO**, a small town of Piedmont in Italy; situated about seven miles west of Turin, in  $7^{\circ}$  E. long. and  $44^{\circ} 40'$  N. lat.

**AVIGNON**, a large city of Provence in France, situated on the east side of the river Rhone, about 20 miles south of Orange, in  $4^{\circ} 40'$  E. long. and  $43^{\circ} 50'$  N. lat. It is an archbishop's see, and, with the whole district of Venaisine, subject to the pope.

**AVIGNON-BERRY**, a name by which some call the fruit of the lycium, used in dying yellow. See **LYCIUM**.

**AVILA**, a beautiful city of Old Castile in Spain, situated 50 miles N. W. of Madrid, in  $5^{\circ} 20'$  W. long. and  $40^{\circ} 50'$  N. lat.

**AVILES**, a sea-port town of Austria in Spain, in  $6^{\circ} 40'$  W. long. and  $43^{\circ} 30'$  N. lat.

**AVIS**, bird, in zoology. See **NATURAL HISTORY**.

**AVIS artica**. See **LARUS**.

**AVIS nivis**. See **LOXIA**.

**AVIS paradisi**. See **MUSCICAPA**.

**AVIS polyglotta**. See **TURDUS**.

**AVIS rabo**. See **PELICANUS**.

**AVIS rabos**. See **PHAETON**.

**AVIS venti**. See **MARGUS**.

**AVIS** is also the name of an order of knighthood in Portugal, instituted by Sancho the first king, in imitation of the order of Alcantara, whose great crosses they wear.

**AVISO**, a term chiefly used in matters of commerce, to denote an advertisement, an advice, or piece of intelligence. See **ADVISE**.

**AUK-**

- AUKLAND**, a market-town on the river Ware, in the bishopric of Durham, situated about 12 miles S. W. of the city of Durham, in  $1^{\circ} 25'$  W. long. and  $54^{\circ} 40'$  N. lat.
- AULCESTER**, a market-town of Warwickshire, situated about fourteen miles south-west of Warwick, in  $1^{\circ} 50'$  W. long. and  $53^{\circ} 20'$  N. lat.
- AULIC**, an epithet given to certain officers of the empire, who compose a court which decides, without appeal, in all processes entered in it. Thus we say, *aulic council*, *aulic chamber*, *aulic counsellor*.
- The aulic council is composed of a president, who is a catholic; of a vice-chancellor, presented by the archbishop of Mentz; and of eighteen counsellors, nine of whom are protestants, and nine catholics. They are divided into a bench of lawyers, and always follow the emperor's court; for which reason they are called *justitium imperatoris*, the emperor's justice, and aulic council. The aulic court ceases at the death of the emperor, whereas the imperial chamber of Spire is perpetual, representing not only the deceased emperor, but the whole Germanic body, which is reputed never to die.
- AULIC**, in the Sorbonne and foreign universities, is an act which a young divine maintains upon being admitted a doctor in divinity. It begins by an harangue of the chancellor, addressed to the young doctor, after which he receives the cap, and presides at the aulic, or disputation.
- AULOS**, a Grecian long measure, the same with stadium.
- AUMBRY**, a country-word denoting a cup-board.
- AUME**, a Dutch measure for Rhenish wine, containing forty English gallons.
- AUNCCEL-WEIGHT**, an ancient kind of balance, now out of use, being prohibited by several statutes, on account of the many deceits practised by it. It consisted of scales hanging on hooks, fastened at each end of a beam, which a man lifted up on his hand. In many parts of England, auncel-weight signifies meat sold by the hand, without scales.
- AUNE**, a long measure used in France to measure cloths, stuffs, ribbons, &c. At Rouen it is equal to one English ell; at Calais, to 1.52; at Lyons, to 1.016; and at Paris, to 0.95.
- AUNIS**, a maritime province of France, on the western shore of the Bay of Biscay, having the province of Poitou on the north, and Santoigne on the south.
- AVOCATORIA**, a mandate of the emperor of Germany, addressed to some prince, in order to stop his unlawful proceedings in any cause appealed to him.
- AVOIDANCE**, in the canon law, is when a benefice becomes void of an incumbent, which happens either in fact, as by the death of the person; or in law, as by cession, deprivation, resignation, &c. In the first of these cases, the patron must take notice of the avoidance, at his peril; but in avoidance by law, the ordinary is obliged to give notice to the patron, in order to prevent a lapse.
- AVON**, a river of England, which, taking its rise in Wiltshire, runs by Bath, where it becomes navigable, and continues its course towards Bristol, below which city it falls into the Severn.
- AVON** is also a river, which, rising in Leicestershire, runs south-west by Warwick and Evesham, and falls into the Severn at Tewksbury in Gloucestershire.
- AVOSETTA**, in ornithology. See *RECURVIROSTRA*.
- AVOWEE**, one who has a right to present to a benefice. See *ADVOWSON*.
- He is thus called in contradistinction to those who only have the lands to which the advowson belongs for a term of years, or by virtue of intrusion or disseisin. See *INTRUSION*, &c.
- AVOWRY**, in law, is where a person distrained sues out a replevin; for then the distrainer must vow, and justify his plea; which is called his avowry. See *REPLEVIN*.
- AURA**, among physiologists, signifies a vapour or exhalation, such as those which arise from mephitical caves. See *MEPHITIS*, and *EXHALATION*.
- AURA vitalis**, in chemistry, a term used by Helmont, for what others call the *flamma vitalis*, or *vital flame*.
- AURA**, in ornithology, the trivial name of a species of vulture. See *VULTURE*.
- AURACH**, a town of Swabia in Germany, situated about 15 miles east of Tubingen, in  $9^{\circ} 20'$  E. long. and  $48^{\circ} 25'$  N. lat.
- AURANCHES**, a large, strong, and well fortified city of France in the Lower Normandy, situated in  $1^{\circ} 16'$  W. long. and  $48^{\circ} 41'$  N. lat.
- AURANTIUM**, in botany. See *CITRUS*.
- AURATA**, in ichthyology, the trivial name of a species of sparus. See *SPARUS*.
- AURATUS equus**. See *EQUES AURATUS*.
- AURAY**, a sea-port town of Brittany in France, situated about 18 miles south-east of Port-Lewis, in  $2^{\circ} 45'$  W. long. and  $47^{\circ} 40'$  N. lat.
- AURELIA**, in natural history, the same with what is more usually called *chrysalis*, and sometimes *nymph*. See *CHRYALIS*.
- AURELIANA**, in botany. See *PINAX*.
- AURENGABAD**, a large city in the province of Vi-siapour in India, on this side the Ganges; E. long.  $5^{\circ} 30'$ , and N. lat.  $19^{\circ} 15'$ .
- AUREOLA**, in its original signification, signifies a jewel, which is proposed as a reward of victory in some public dispute. Hence, the Roman schoolmen applied it to denote the reward bestowed on martyrs, virgins, and doctors, on account of their works of supererogation; and painters use it to signify the crown of glory, with which they adorn the heads of saints, confessors, &c.
- AUREUS**, a Roman gold coin, equal in value to twenty-five denarii.
- AURICH**, a town of Westphalia in Germany, situated about 12 miles north-east of Embden, in  $6^{\circ} 50'$  E. long. and  $53^{\circ} 40'$  N. lat.
- AURICHALCUM**, or *ORICHALCUM*. See *ORICHALCUM*.
- AURICLE**, in anatomy, that part of the ear which is prominent from the head, called by many authors *auris externa*. See p. 295.

AURI-



**AURICLES** are likewise two muscular bags situated at the basis of the heart. See p. 279.

**AURICULA**, in botany, a synonyme of the dodecatheon and several other plants. See **DODECATHÉON**, **PRI-MULA**, **ARENARIA**, &c.

**AURICULARIS DIGITUS**, the little finger, so called, because it is used commonly to pick the ear.

**AURIGA**, *the Wagoner*, in astronomy, a constellation of the northern hemisphere. See **ASTRONOMY**, p. 486.

**AURILLAC**, a neat and well-built city of France, in the Upper Avergne, noted for its trade in bone-lace: it is situated in  $30^{\circ} 31'$  E. long. and  $54^{\circ} 44'$  N. lat.

**AURIPIGMENTUM**, orpiment, in natural history. See **ORPIMENT**.

**AURISCALPIUM**, an instrument to clean the ears, and serving also for other operations in disorders of that part.

**AURORA**, the morning-twilight, or that faint light which appears in the morning, when the sun is within eighteen degrees of the horizon.

**AURORA BOREALIS**, is an extraordinary meteor, shewing itself in the night time, in the northern part of the heavens. See **PNEUMATICS**, *Of Meteors*.

**AURUM**, gold, in natural-history. See **CHEMISTRY**, *Of metals*.

**AUSPEX**, a name anciently used for augur. See **AUGUR**.

**AUSTRAL**, something relating to the south: thus the six signs on the south side of the equinoctial are called *austral signs*.

**AUSTRAL Fish**, a small constellation of the southern hemisphere, invisible to us.

**AUSTRIA**, a circle of Germany, comprehending the arch-duchy of Austria, also Styria, Carinthia, Carniola, Tyrol, Trent, and Brixen. It is bounded by Bohemia and Moravia on the north; by Hungary, Sclavonia, and Croatia on the east; by the dominions of Venice on the south, and by Bavaria on the west.

**AUSTRIAN Netherlands**. See **NETHERLANDS**.

**AUTHENTIC**, something of acknowledged and received authority. In law, it signifies something clothed in all its formalities, and attested by persons to whom credit has been regularly given. Thus we say, authentic papers, authentic instruments.

**AUTHOR**, properly signifies one who created or produced any thing. Thus God, by way of eminence, is called the author of nature, the author of the universe.

**AUTHOR**, in matters of literature, a person who has composed some book or writing.

**AUTHORITY**, in a general sense, signifies a right to command, and make one's self obeyed. In which sense, we say, the royal authority, the episcopal authority, the authority of a father, &c. It denotes also the testimony of an author, some apophthegm or sentence of an eminent person quoted in a discourse by way of proof.

Authority is represented, in painting, like a grave matron sitting in a chair of state, richly clothed in a garment embroidered with gold, holding in her right-hand a sword, and in her left a sceptre. By her side is a double trophy of books and arms.

**AUTO DE FE**, act of faith. See **ACT of faith**.

**AUTOGRAPH**, denotes a person's hand-writing, or the original manuscript of any book, &c.

**AUTOMATUM**, or **AUTOMATON**, an instrument, or rather machine, which by means of springs, weights, &c. seems to move itself, as a watch, clock, &c. Such also were Archytus's flying dove, Regiomontanus's wooden-eagle, &c.

**AUTUMN**, the third season of the year, when the harvest and fruits are gathered in.—Autumn is represented, in painting, by a man at perfect age, clothed like the vernal, and likewise girded with a starry girdle; holding in one hand a pair of scales equally poised, with a globe in each; in the other a bunch of divers fruits and grapes. His age denotes the perfection of this season; and the balance, that sign of the zodiac which the sun enters when our autumn begins.

**AUTUMNAL Point**, is that part of the equinox from which the sun begins to descend towards the south pole.

**AUTUMNAL Signs**, in astronomy, are the signs Libra, Scorpio, Sagittarius, through which the sun passes during the autumn.

**AUTUMNAL Equinox**, that time when the sun enters the autumnal point.

**AUTUN**, a city of Burgundy in France, situated on the river Arroux, in  $4^{\circ} 15'$  E. long. and  $46^{\circ} 50'$  N. lat.

**AUVERGNE**, a territory of the Lyonois in France; lying between the Bourbonnois on the north, and the Cevennes on the south.

**AUX**, in astronomy, the same with the apogeeum of the ancients, or the aphelium of the moderns. See **APOGEEUM** and **APHELIIUM**. It also denoted the arch of the ecliptic, intercepted between the first degree of Aries and the apogeeum.

**Aux**, or **AUGH**, in geography, the capital city of Gascony in France. It is one of the richest archbishop's sees in France, though but a small town; situated in  $20'$  E. long. and  $43^{\circ} 40'$  N. lat.

**AUXERRE**, a city of Burgundy, in France, situated on the river Yonne, in  $3^{\circ} 35'$  E. long. and  $47^{\circ} 40'$  N. lat.

**AUXILIARY**, whatever is aiding or helping to another.

**AUXILIARY Verbs**, in grammar, are such as help to form or conjugate others; that is, are prefixed to them, to form or denote the moods or tenses thereof; as *to have* and *to be*, in the English; *être* and *avoir*, in the French; *ho* and *sono* in the Italian, &c.

In the English language, the auxiliary verb *am*, supplies the want of passive verbs.

**AUXONE**, a small city of Burgundy, in France, situated on the river Soane, about seven miles west of Dole, in  $5^{\circ} 22'$  E. long. and  $47^{\circ} 15'$  N. lat.

**AWARD**, in law, the judgment of an arbitrator, or of one who is not appointed by the law a judge, but chosen by the parties themselves for terminating their difference. See **ARBITER**.

**AWL**, among shoe-makers, an instrument wherewith holes are bored through the leather, to facilitate the stitching or sewing the same. The blade of the awl is usually a little flat and bended, and the point ground to an acute angle.

**AWME**, or **AUME**, a Dutch liquid measure containing

- eight steckans, or twenty verges or verteels, equal to the tierce in England, or to one sixth of a tun of France.
- AWN**, in botany. See **ARISTA**.
- AWNING**, in the sea-language, is the hanging a sail, tarpaulin, or the like, over any part of the ship, to keep off the sun, rain, or wind.
- AX-VETCH**. See **SECURIDACA**.
- AXBRIDGE**, a market-town of Somersetshire, situated about eight miles north-west of Wells, in  $3^{\circ}$  W. long. and  $51^{\circ} 30'$  N. lat.
- AXEL**, a small fortified town of Dutch Flanders, situated about 20 miles west of Antwerp, in  $3^{\circ} 40'$  E. long. and  $51^{\circ} 20'$  N. lat.
- AXILLA**, in anatomy, the arm-pit, or the cavity under the upper part of the arm.
- AXILLA**, in botany, the angle formed by a branch and the stem, or a leaf and the branch.
- AXIM**, a town on the Gold Coast of Guinea, where the Dutch have a fort and factory, called *St. Anthony*:  $4^{\circ}$  W. long. and  $5^{\circ}$  N. lat.
- AXIOM**, in philosophy, any plain, self-evident, and received notion, that cannot be made more plain and evident by demonstration. It is also an established principle in some art or science.
- AXIOPOLIS**, a town of Bulgaria, subject to the Turks. It stands upon the river Danube.
- AXIS**, in geometry, the straight line in a plain figure, about which it revolves, to produce or generate a solid: thus, if a semi-circle be moved round its diameter at rest, it will generate a sphere, the axis of which is that diameter.
- AXIS**, in astronomy, is an imaginary right line supposed to pass through the centre of the earth, and the heavenly bodies, about which they perform their diurnal revolutions.
- AXIS**, in conic-sections, a right line dividing the section into two equal parts, and cutting all its ordinates at right angles. See **CONIC SECTIONS**.
- AXIS**, in mechanics. The axis of a balance is that line about which it moves, or rather turns about. Axis of oscillation is a right line parallel to the horizon, passing through the centre about which a pendulum vibrates. See **MECHANICS**.
- AXIS in peritrochio**, one of the five mechanical powers, consisting of a peritrochium or wheel concentric with with the base of a cylinder, and moveable together with it about its axis. See **MECHANICS**.
- AXIS**, in optics, is that particular ray of light coming from any object which falls perpendicularly on the eye. See **OPTICS**.
- AXIS**, in architecture, spiral axis, is the axis of a twisted column drawn spirally, in order to trace the circumvolutions without.
- Axis of the Ionic capital, is a line passing perpendicularly through the middle of the eye of the volute. See **ARCHITECTURE**.
- Axis of a vessel is an imaginary right line passing through the middle of it perpendicularly to its base, and equally distant from its sides.
- AXIS**, in anatomy, the second vertebra of the neck, so called from the head's turning on it like an axis.
- AXIS**, in zoology. See **CERVUS**.
- AXMINSTER**, a market-town of Devonshire, situated about 22 miles east of Exeter, in  $3^{\circ} 15'$  W. long. and  $50^{\circ} 40'$  N. lat.
- AXUMA**, a city of Ethiopia in Africa, situated in  $38^{\circ}$  E. long. and  $15^{\circ}$  N. lat.
- AXUNGIA**, in a general sense, denotes old lard, or the driest and hardest of any fat in the bodies of animals: But, more properly, it signifies only hogs-lard.
- AXUNGIA folis**, in natural history, the same with the Silesian earth.
- AXUNGIA vitri**, SANDIVER, or SALT of glass, a kind of salt which separates from the glass while it is in fusion. It is of an acrimonious and biting taste. The farriers use it for cleansing the eyes of horses. It is also made use of for cleansing the teeth; and is sometimes applied to running ulcers, the herpes, or the itch, by way of desiccative.
- AXYRIS**, in botany, a genus of the monœcia triandria class. The calix of the male is tripartite; it has no corolla. The calix of the female consists of two leaves; it has two styli, and one seed. The species are 4, none of them natives of Britain.
- AYAMONTE**, a sea-port town of Andalusia, in Spain, situated near the mouth of the river Guadiana, in  $8^{\circ} 5'$  W. long. and  $37^{\circ}$  N. lat.
- AYENIA**, in botany, a genus of the gynœndria pentandria class. The calix has two leaves; the petals are in the form of a star, with long unguis; and the capsule has five cells. There are three species, all natives of the W. Indies.
- AYRY**, or **AERY of hawks**, a nest or company of hawks, so called from the old French word *aire*, which signified the same.
- AZAB**, in the Turkish armies, a distinct body of soldiery, who are great rivals of the Janizaries.
- AZALEA**, in botany, a genus of the pentandria monogynia class. The corolla is bell-shaped; the stamina are inserted into the receptacle; and the capsule has five cells. The species are six, most of them natives of America.
- AZAMOR**, a maritime city of Africa, in the kingdom of Morocco, and province of Duqucla, situated in  $6^{\circ} 30'$  W. long. and  $32^{\circ} 50'$  N. lat.
- AZAROLUS**, in botany. See **CRATÆGUS**.
- AZARUM**, in botany. See **ASARUM**.
- AZAZEL**, the scape-goat, in Jewish antiquity. See **SCAPE-GOAT**.
- AZED**, in the materia medica, a kind of camphor. See **CAMPHOR**.
- AZERADACH**, in botany. See **MELIA**.
- AZIMUTH**, in astronomy, an arch of the horizon, intercepted between the meridian of the place and the azimuth, or vertical circle passing through the centre of the object, which is equal to the angle of the zenith, formed by the meridian and vertical circle; or it is found by this proportion, as the radius to the tangent of the latitude of the place, so is the tangent of

of the sun's or star's altitude, for instance, to the cosine of the azimuth from the south, at the time of the equinox. To find the azimuth by the globe, see **GEOGRAPHY**.

**Magnetical AZIMUTH**, an arch of the horizon intercepted between the azimuth, or vertical circle, passing through the centre of any heavenly body, and the magnetical meridian. This is found by observing the object with an azimuth-compass.

**AZIMUTH-compass**, an instrument adapted to find, in a more accurate manner than by the common sea-compass, the sun or stars magnetical amplitude, or azimuth. See **COMPASS**.

**AZIMUTH-dial**, one whose style or gnomon is at right angles to the plane of the horizon.

**AZIMUTH-circles**, called azimuths, or vertical circles, are great circles of the sphere, intersecting each other in the zenith and nadir, and cutting the horizon at right angles in all the points thereof.

**AZOGA ships**, are those Spanish ships commonly called the *quick-silver ships*, from their carrying quick-silver to the Spanish W. Indies, in order to extract the silver out of the mines of Mexico and Peru. These ships, strictly speaking, are not to carry any goods unless for the king of Spain's account.

**AZONI**, in ancient mythology, a name applied by the Greeks to such of the gods as were deities at large, not appropriated to the worship of any particular town or country; but acknowledged in general by all countries, and worshipped by every nation. These the Latins called *dii communes*. Of this sort were the sun, Mars, Luna, &c.

**AZOPH**, in geography. See **АЗОРН**.

**AZORES**, islands in the Atlantic ocean, between 25° and 33° W. long. and between 36° and 40° N. lat. They belong to the Portuguese, and are sometimes called the Western Isles, as lying westward of Europe.

**AZOTH**, in ancient chemistry, the first matter of metals, or the mercury of a metal; more particularly that which they call the *mercury of philosophers*, which they pretend to draw from all sorts of metallic bodies.

**AZURE**, in a general sense, the blue colour of the sky. See **SKY** and **BLUE**.

**AZURE**, among painters, the beautiful blue colour, with a greenish cast, prepared from the lapis lazuli, generally called *ultramarine*.

With greater propriety, however, azure signifies that bright blue colour prepared from the lapis armenus, a different stone from the lapis lazuli, though frequently confounded together. This colour is, by our painters, commonly called *Lambert's blue*.

**AZURE**, in heraldry, the blue colour in the arms of any person below the rank of a baron. In the escutcheon of a nobleman, it is called *sapphire*; and in that of a sovereign prince, *Jupiter*. In engraving, this colour is expressed by lines, or strokes drawn horizontally.

**AZURIUM**, the name of a chemical preparation from two parts of mercury, one of sulphur, and a fourth of sal ammoniac, mixed in a mortar, put into a glass vessel, and set over the fire till a bluish smoke arises, &c.

**AZYGOS**, in anatomy, a vein rising within the thorax on the right side, having no fellow on the left; whence it is called *azygos*, or *vena sine pari*. See **ANATOMY**, p. 237.

**AZYMITES**, in church-history, Christians who administer the eucharist with unleavened bread. This is an appellation given by the Latin to the Greek church; who also call the Armenians and Maronites, who use unleavened bread in their office, by the name of *Azymites*.

**AZYMOUS**, something unfermented, as bread, &c. made without leaven.



## B

### B A B

**B AAR**, a country of Swabia in Germany, in the principality of Furstenberg, near the source of the Danube and the Necker.

**BABELMANDEL**, a little island at the entrance of the Red-sea, from the Indian ocean; from whence the straits of Babelmandel take their name.

**BABOON**, in zoology, a synonyme of the *simia sphinx*. See **SIMIA**.

**BABYLON**, a celebrated city of antiquity, supposed to have been situated on the river Euphrates, though not on its present channel, in 44° E. long. and 32° N. lat. But of this once so flourishing a city, there are now no remains; nor is even the place where it stood certainly known.

### B A C

**BABYLON** was also an ancient city of Egypt, supposed to have stood where Grand Cairo does at present.

**BABYROUSSA**, in zoology, a synonyme of a species of *fus*. See **SUS**.

**BACA**, a town of Granada, in Spain, situated about 48 miles north-east of the city of Granada, in 3° W. long. and 37° 30' N. lat.

**BACALIAU**, or **BARCALLAO**. See **BARCALLAO**.

**BACCA**, berry, in botany. is used to signify such fruits as consist of a pericarpium full of juice and seeds, without any valves.

**BACCARAT**, a town of Lorraine upon the Meuse, between Nanci and Estival.

**BACA.**

**BACCASERAI**, the capital city of Crim-Tartary, situated about 80 miles west of the Straits of Kassa, in 35° E. long. and 45° 15' N. lat.

**BACCEM**, or **BACIAIM**, a sea-port town of Cambaya, in the Hither Peninsula of India. It belongs to the Portuguese, and is situated in 73° E. long. and 19° 20' N. lat.

**BACCHÆ**, in antiquity, priestesses of the god Bacchus. They were likewise called *menades*, on account of the frantic ceremonies used in their feasts; as also *thyades*, which signifies *impetuous* or *furious*. They celebrated the orgies of their god covered with skins of tigers and panthers, and running all the night, some with their hair loose, with torches in their hands, others crowned with vine and ivy leaves, carrying a thyrsus or rod, turned about with ivy, in their hand. Along with them went cymbal-players and drummers, while they themselves, seized with enthusiasm, made hideous lamentations.

**BACCHANALIA**, feasts celebrated in honour of Bacchus by the ancient Greeks and Romans; of which the two most remarkable were called the *greater* and *lesser*. The latter, called *lenæa*, from a word signifying a *wine-press*, were a preparation for the former, and were held in the open fields about autumn; but the greater, called *Dionysia*, from one of the names of Bacchus, were celebrated in the city, about the spring-time. Both these feasts were accompanied with games, spectacles, and theatrical representations; and it was at this time the poets contended for the prize of poetry. Those who were initiated into the celebration of the feasts, represented, some Silenus, others Pan, others satyrs; and in this manner appeared in public night and day, counterfeiting drunkenness, dancing obscenely, committing all kinds of licentiousness and debauchery, and running over the mountains and forests, with horrible shrieks and howlings, crying out, *Io Bacche*. Livy informs us, that during the Bacchanalian feasts at Rome, such shocking disorders were practised under the cover of the night, and those who were initiated were bound to conceal them with an oath, attended with horrid imprecations, that the senate suppressed them first in Rome, and afterwards throughout all Italy.

**BACCHARAC**, or **BACHERAC**. See **BACHERAC**.

**BACCHARIS**, in botany, a genus of the syngenesia polygamia superflua class. The receptacle is naked, and the pappus bristly; the calix is imbricated and cylindrical; the hermaphrodite floscules are intermixed with the female ones. The species are seven, all natives of warm climates.

**BACCHIUS**, in ancient poetry, a kind of foot composed of a short syllable, and two long ones, as the word [āvārī]. It takes its name from the god Bacchus, because it frequently entered into the hymns composed in his honour. The Romans called it likewise *enotrius*, *tripodius*, *saltans*.

**BACHARIS**, in botany. See **BACCHARIS**.

**BACHELOR**. See **BATCHELOR**.

**BACHERAC**, a town of the Palatinate of the Rhine, situated on the western shore of that river, in 7° E. lon.

and 50° N. lat. It is remarkable for excellent wine, from thence called *Bacherac*.

**BACHIAN**, one of the Molucca islands, situated under the equator, in 125° E. long. It belongs to the Dutch.

**BACHU**, a sea-port town of the province of Chirwan, or Shirvan, in Persia. It is situated on the western shore of the Caspian sea, in 49° E. long. and 40° N. lat.

**BACK**, in anatomy. See **BACK-bone**.

**BACK**, in the menage. To back a horse, or mount a horse *a dos*, in French, is to mount him bare-backed, or without a saddle.

**BACK-bone**, or **SPINE**. See **ANATOMY**, p. 166, 167.

**BACK-gammon**, an ingenious game played with dice and tables, to be learned only by observation and practice.

**BACK painting**. See **PAINTING**.

**BACK-staff**, in the sea-language. See **NAVIGATION**.

**BACK-stays**. See **STAYS**.

**BACK-tack**, in Scots law: When a wadsetter, instead of possessing the wadset-lands, grants a tack thereof to the reverfor for payment of a certain sum in name of tack-duty, that tack is called a *back-tack*. See **SCOTS LAW**, tit. *Redeemable rights*.

**BACK-worm**, in falconry. See **FILANDERS**.

**BACULE**, in fortification, a kind of portcullis, or gate, made like a pit-fall with a counterpoise, and supported by two great stakes. It is usually made before the corpade-guard, not far from the gate of a place.

**BACULOMETRY**, the art of measuring accessible or inaccessible heights, by the help of one or more baculi, staves, or rods. See **GEOMETRY**.

**BACULUS divinatorius**. See **VIRGULA DIVINA**.

**BADAJOX**, a large fortified town of Spanish Extremadura, situated on the river Guadiana, in 7° 20' W. long. and 38° 45' N. lat.

**BADALON**, a town of Catalonia, in Spain, situated on the Mediterranean, about ten miles east of Barcelona, in 2° 15' E. long. and 41° 15' N. lat.

**BADEN**, the name of several towns: 1. Of one about 20 miles north of Strasbourg, capital of the margraviate of the same name, and remarkable for its hot baths. 2. Of another town of Swabia, in the Brisgow; where are likewise several hot baths. 3. Of one in Switzerland, about 14 miles north-west of Zurich. 4. Of one in the circle of Austria, about 15 miles south of Vienna.

**BADENOCH**, an inland country of Invernessshire in Scotland, lying between Aberdeenshire and Lochaber.

**BADENWEILLER**, a town of Germany, in the Brisgow, near the Rhine.

**BADGER**, in zoology, the English name of a species of *Ursus*. See **URSUS**.

**BADGER**, in old law-books, one that was licensed to buy corn in one place, and carry it to another to sell, without incurring the punishment of an engrosser.

**BADIANE**, or **BANDIAN**, the seed of a tree which grows in China, and smells like anise-feed. The Chinese, and the Dutch in imitation of them, sometimes use the badiane to give their tea an aromatic taste.

**BADIS**,

**BADIS**, a fortress of Livonia, subject to Russia, and situated 20 miles west of Revel, in 23° E. long. and 59° 15' N. lat.

**BÆTUS**, in ichthyology. See **COTTUS**.

**BÆTYLIA**, anointed stones, worshipped by the Phœnicians, by the Greeks before the time of Cæcrops, and by other barbarous nations. They were commonly of a black colour, and consecrated to some god, as Saturn, Jupiter, the Sun, &c.

**BÆZA**, a large city of Andalusia in Spain. situated on the river Guadalquivir, in 3° 15' W. long. and 37° 40' N. lat.

**BAFFETAS**, or **BASTAS**, a cloth made of coarse white cotton-thread, which comes from the East Indies. That of Surat is the best.

**BAFFIN'S Bay**, a gulph of North America, running north-east from Cape Farewell in West Greenland, from 60° N. lat. to 80°.

**BAG**, in-commerce, a term signifying a certain quantity of some particular commodity; as a bag of almonds, for instance, is about three hundred weight; of anise-seeds, from three to four hundred, &c.

Bags are used in most countries to put several sorts of coin in, either of gold, silver, brass, or copper. Bankers, and others, who deal much in current cash, label their bags of money, by tying a ticket or note at the mouth of the bag, signifying the coin therein contained, the sum total, its weight, and of whom it was received. Tare is allowed for the bag. See **TARE** and **TRET**.

**BAG**, among farriers, is when, in order to retrieve a horse's lost appetite, they put in an ounce of asa-fœtida, and as much powder of favin, into a bag, to be tied to the bit, keeping him bridled for two hours, several times a-day; as soon as the bag is taken off, he will fall to eating. The same bag will serve a long time.

**BAGDAT**, a strong town of Turkey, on the frontiers of Persia, situated on the river Tigris, in the province of Iracaarabic; it was formerly capital of the Saracen empire, and lies in 43° E. long. and 33° 20' N. lat.

**BAGGAGE**, in military affairs, denotes the cloaths, tents, utensils of divers sorts, provisions, and other necessaries belonging to the army.

Before a march, the waggons with the baggage are marshalled according to the rank which the several regiments bear in the army; being sometimes ordered to follow the respective columns of the army, sometimes to follow the artillery, and sometimes to form a column by themselves. The general's baggage marches first; and each waggon has a flag, shewing the regiment to which it belongs.

**BAGNAGAR**, the capital of Golconda, in the Hither Peninsula of India, formerly the residence of the kings of Golconda, now subject to the mogul; in 77° 30' E. long. and 16° 30' N. lat.

**BAGNIALUCK**, a large city of Bosnia in European Turkey, situated in 18° 15' E. long. and 44° N. lat.

**BAGNIO**, an Italian word, signifying a bath: We use it for a house with conveniences for bathing, cupping, sweating, and otherwise cleansing the body; and some-

times for worse purposes. In Turkey, it is become a general name for the prisons where the slaves are inclosed, it being usual in these prisons to have baths.

**BAGNOLIANS**, in church-history, a sect of heretics, who in reality were Manichees, though they somewhat disguised their errors. They rejected the Old Testament, and part of the New, held the world to be eternal, and affirmed that God did not create the soul when he infused it into the body.

**BAGPIPE**, a musical instrument of the wind kind, chiefly used in country-places, especially in the North. It consists of two principal parts; the first a leathern bag, which blows up like a foot-ball, by means of a port-vent, or little tube, fitted to it, and stopped by a valve: the other part consists of three pipes or flutes; the first called the *great pipe*, or *drone*; the second, the *little one*; which pass the wind out only at the bottom; the third has a reed, and is played on by compressing the bag under the arm, when full, and opening or stopping the holes, which are eight, with the fingers. The little pipe is ordinarily a foot long; that played on, 13 inches; and the port-vent, six.

**BAGRE**, in ichthyology, the trivial name of a species of silurus. See **SILURUS**.

**BAGUETTE**, in architecture, a small round moulding, less than an astragal, and so called from the resemblance it bears to a ring.

**BAHAMA**, or **LUCAYA ISLANDS**, a number of islands lying in the Atlantic Ocean, between 21° and 27° N. lat. and between 73° and 81° W. long.

These islands, whereof twelve are of a considerable extent, take their name from Bahama, one of the largest of them, lying between 78° and 81° W. long. and between 26° and 27° N. lat.

**BAHAR**, or **BAKRE**, in commerce, weights used in several places in the East Indies.

There are two of these weights, one the great bahar, with which they weigh pepper, cloves, nutmegs, ginger, &c. and contains five hundred and fifty pounds of Portugal, or about five hundred and twenty-four pounds nine ounces avoirdupois weight. With the little bahar, they weigh quicksilver, vermilion, ivory, silk, &c. It contains about four hundred and thirty-seven pounds nine ounces avoirdupois weight.

**BACHAREN**, an island in the Persian gulf, in 50° E. long. and 26° N. lat.

**BAHIR**, a Hebrew term signifying famous or illustrious; but particularly used for a book of the Jews, treating of the profound mysteries of the cabbala, being the most ancient of the rabbinical works.

**BAHUS**, a city of Sweden, capital of a province of the same name, and situated about 20 miles north-west of Gottenburgh, in 11° E. long. and 58° 20' N. lat.

**BAJA**, a town of Italy, in the kingdom of Naples, and province of Lavoro, situated in 14° 40' E. long. and 41° 6' N. lat.

**BAJADOR**, a cape on the west coast of Africa, in 15° W. long. and 27° N. lat.

**BAIL**, in Scots law: When a prisoner is set at liberty upon some person's becoming surety for his appearance

- to stand trial under a penalty, he is said to be *admitted to bail*. See SCOTS LAW, tit. *Crimis*.
- Clerk of the BAILS*, is an officer belonging to the court of the King's Bench: he files the bail-pieces taken in that court, and attends for that purpose.
- BAIL, or BALE, in the sea-language. The seamen call throwing the water by hand, out of the ship or boat's-hold, *bailing*. They also call those hoops that bear up the tilt of a boat, its *bails*.
- BAILIAGE, or BAILIWICK. See BAILIWICK.
- Water BAILIAGE*, an ancient duty paid to the city of London, for all goods brought into, or carried out of, the port.
- BAILIE, in Scots law, a judge anciently appointed by the king over such lands not erected into a regality as happened to fall to the crown by forfeiture or otherwise, now abolished. It is also the name of a magistrate in royal boroughs, and of the judge appointed by a baron over lands erected into a barony. See SCOTS LAW, tit. *Inferior judges, &c.*
- BAILIFF, an officer appointed for the administration of justice within a certain district, called a *bailiwick*.
- BAILIFFS-*errant*, such as are appointed by the sheriff, to go up and down the country, to serve writs and warrants, summon country-courts, sessions, assizes, and the like.
- BAILIFFS *of franchises*, those appointed by every lord within his liberty to do such offices therein as the bailiff-errant does at large in the country.
- There are also bailiffs of forests, and bailiffs of manors, who direct husbandry, fell trees, gather rents, pay quit-rents, &c.
- Water-BAILIFF*, an officer appointed in all port-towns, for the searching of ships, gathering the toll for anchorage, &c. and arresting persons for debt, &c. on the water.
- BAILIWICK, that liberty which is exempted from the sheriff of the county; over which liberty the lord thereof appoints his own bailiff, with the like power within his precinct, as an under-sheriff exercises under the sheriff of the county: Or it signifies the precinct of a bailiff, or the place within which his jurisdiction is terminated.
- BAILO, thus they style at Constantinople the ambassador of the republic of Venice, who resides at the Porte. This minister, besides his political charge, acts there the part of a consul of Venice.
- BAIOCAO, a copper-coin, current at Rome, and throughout the whole state of the church, ten of which make a *julio*, and an hundred a Roman crown.
- BAIRAM, in the Mahometan customs, a yearly festival of the Turks, which they keep after the fast of Ramazan.
- The Mahometans have two bairams, the great and the little. The little bairam holds for three days, and is seventy days after the first, which follows immediately the ramazan. During the bairam, the people leave their work for three days, make presents to one another, and spend the time with great manifestations of joy. If the day after ramazan should be so cloudy as to prevent the sight of the new moon, the bairam is put off to the next day, when it is kept, even if the moon should still be obscured; when they celebrate this feast, after numerous ceremonies, or rather strange mimickries, in their mosque, it is concluded with a solemn prayer against the infidels, to extirpate Christian princes, or to arm them against one another, that they may have an opportunity to extend the borders of their law.
- BAIT, in fishing. See FISHING.
- BAITING, in falconry, is when a hawk flutters with her wings, either from perch or *sit*, as if it were striving to get away.
- BAJULUS, an ancient officer in the court of the Greek emperors. There were several degrees of bajuli, as the grand bajulus, who was preceptor to the emperor; and the simple bajuli, who were sub-preceptors.
- BAKAL, a great lake in the middle of Siberia, on the road from Muscovy to China.
- BAKER, a person whose occupation or business it is to bake bread. See BAKING.
- BAKEWELL, a large market town of Derbyshire, about 150 miles from London. It is a good market for lead.
- BAKING, the art of preparing bread, or reducing meals of any kind, whether simple or compound, into bread.
- The various forms of baking among us may be reduced into two, the one for leavened, the other for unleavened bread; for the first, the chief is manchet-baking, the process whereof is as follows.
- The meal, ground and bolted, is put into a trough, and to every bushel are poured in about three pints of warm ale, with barm and salt to season it: this is kneaded well together with the hands through the brake; or for want thereof, with the feet, through a cloth; after which, having lain an hour to swell, it is moulded into manchets, which scorch'd in the middle, and pricked at top, to give room to rise, are baked in the oven by a gentle fire.
- For the second, sometimes called cheat-bread baking, it is thus: some leaven (saved from a former batch) filled with salt, laid up to sour, and at length dissolved in water, is strained through a cloth into a hole made in the middle of the heap of meal in the trough; then it is worked with some of the flour into a moderate consistence; this is covered up with meal, where it lies all night, and in the morning the whole heap is stirred up, and mixed with a little warm water, barm, and salt, by which it is seasoned, softened, and brought to an even leaven: it is then kneaded, moulded, and baked, as before.
- BAKING *of porcelain*. See PORCELAIN.
- BALA, in geography, a market-town of Marionethshire, about 16 miles south from Denbigh, in 3° 40' W. long. and 52° 55' N. lat.
- BALÆNA, or WHALE, in zoology, a genus of the mammalia class, belonging to the order of cetæ. The characters of this genus are these: The balæna, in place of teeth, has a horny plate in the upper jaw, and a double fistula or pipe for throwing out water. The species are four; viz. 1. The mylicærus, which has many turnings and windings in its nostrils, and has no fin on the back. This is the largest of all animals; it is often

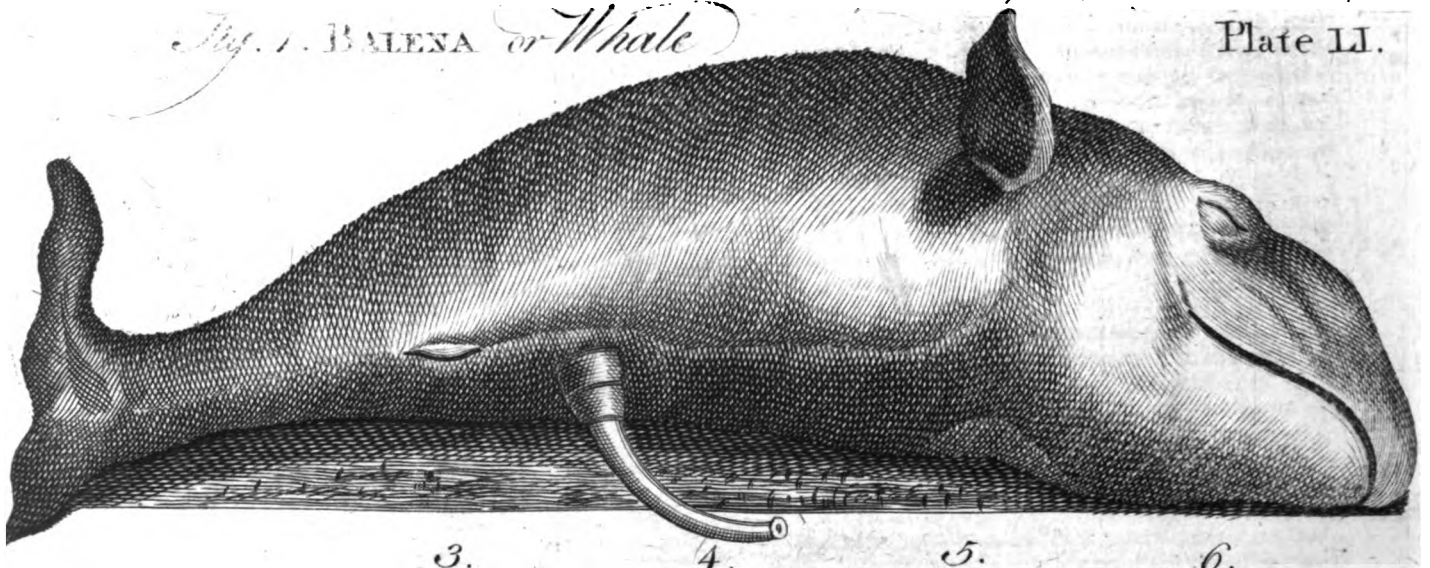
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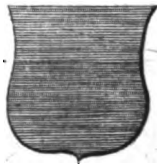
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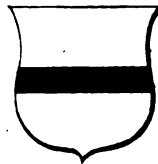
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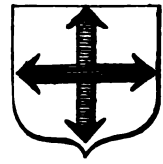
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5. BARR GEMELLE



6. BARBED CROSS



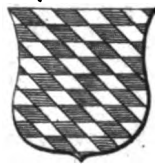
7.

BARRULY or BARRY



8.

BARRY BENDY



9.

BASTON



10.

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11.

BENDS  
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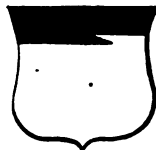
12.

BENDY



13.

BEVILE



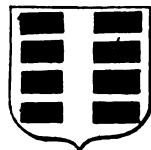
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BEZANTS



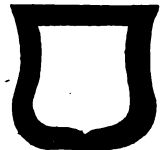
15.

BILLETS



16.

BORDURE



17.

BOTTONY



18.

BRACED



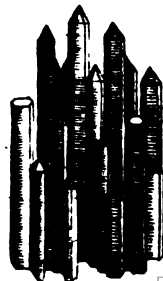
19.

BARONS CORONET



20.

BASALTES



21.

BELEMNITZ





- often 100 feet long: the head is very large in proportion to the body; and the lower jaw is much wider than the upper one: the ears are situated below the eyes. In the belly, it has two dug a little before the vulva; there are two large fins on the breast; and the tail is forked. The mysticetus contains such a large quantity of fat, that a ship is often loaded with the blubber obtained from a single fish. It is a native of the Greenland Ocean. It feeds chiefly upon the medusa, a small sea-insect. See MEDUSA. The substance called whale-bone is got from the upper lip, and towards the throat of this and all the other species of whales. See Plate LI. fig. 1. For the manner of taking whales, see WHALE-FISHERY. 2. The physalus, has a double pipe in the middle of the head, and a thick fat fin on the lower part of the back, besides the two fins on the breast; it has no teeth; and the belly is smooth. The physalus inhabits the European and American oceans: it feeds upon herrings and other small fish. 3. The boops has a double pipe in its snout, three fins like the former, and a hard horny ridge on its back. The belly is full of longitudinal folds or rugæ. It frequents the northern ocean. 4. The musculus has a double pipe in its front, and three fins; the under jaw is much wider than the upper one. It frequents the Scotch coasts, and feeds upon herrings.—Linnæus makes the physeter and delphinus, which are ranked among the whales by some writers, two distinct genera. See PHYSETER and DELPHINUS.
- BALAGNA**, a town of Muscovy, in the province of Novogorod, situated on the river Wolga, in 45° E. long. and 56° 30' N. lat.
- BALAMBUAN**, a sea-port town of the isle of Java, in Asia, which gives name to the channel called the *Streights of Balambuan*.
- BALAM-PULLI**, in botany. See TAMARINDUS.
- BALANCE**, or **BALANCE**. See BALANCE.
- BALANGIAR**, the capital city of Tartary, north of the Caspian sea.
- BALANUS**, in zoology, the trivial name of a species of lepas. See LEPAS.
- BALANUS**, in anatomy, a term sometimes used for the glans penis, as well as for the clitoris.
- BALANUS**, in pharmacy, denotes a suppository. See SUPPOSITORY.
- BALASS**, or **BALLAS**, the name of a kind of ruby. See RUBY.
- BALAUSTIA**, in botany. See PUNICA.
- BALBASTRO**, a city of Arragon, in Spain, situated upon the river Sinca, fifty miles north-east of Saragossa.
- BALBEC**, a town of Asiatic Turkey, situated at the foot of mount Libanus, in 37° 30' E. long. and 33° N. lat.
- BALCHA**, a city of Usbec Tartary, situated on the frontiers of Persia, in 65° 20' E. long. and 37° N. lat.
- BALCONY**, in architecture, a projecture in the front of a house, or other building, supported by pillars or consoles, and encompassed with a balustrade.
- BALDACHIN**, or **BALDAQUIN**, in architecture, a building in form of a canopy, supported by pillars, and frequently used as a covering to insulated altars. Some also use the term baldachin for the shell over a door.
- BALDIVIA**, or **VALDIVIA**, a sea-port town of Chili, in South America, situated on the South Sea, in 80° W. long. and 40° S. lat.
- BALDNESS**, a defect of hair, owing to the want of a sufficient supply of nutritious juice.
- BALDOC**, a market-town in Hertfordshire, about 38 miles north of London, in 15° W. long. and 51° 55' N. lat.
- BALE**, in commerce: Any goods packed up in cloth, and corded round very tight, in order to keep them from breaking, or preserve them from the weather, is called a *bale*.
- A bale of cotton yarn is from three to four hundred weight; of raw silk, is from one to four hundred; of lockram or dowlafs, either three, three and a half, or four pieces.
- BALE-GOODS**, among the English merchants, are all such as are imported or exported in bales; but the French give that name to certain hard-wares, and other sort of merchandize, which come to Paris, and are commonly made by bad workmen, of indifferent materials.
- BALI**, an island in the East Indies, situated in 114° E. long. and 7° 30' S. lat. This island, and the east end of the island of Java, form a straight about a mile over, of extremely difficult passage.
- BALISORE**, a small sea-port of the Hither India, situated on the north-west part of the bay of Bengal, in 85° 15' E. long. and 21° 30' N. lat.
- BALISTA**, or **BALLISTA**. See BALLISTA.
- BALISTES**, in ichthyology, a genus of fishes belonging to the order of amphibia nantes. The characters are these: The head is flat; there are eight teeth in each side, and the two anterior ones are longest; in the place of gills, the balistes has an aperture immediately above the pectoral fins; the body is flat, the scales are joined together by the skin, and the belly is keeled. The species of this genus are eight; viz. the balistes monoceros, whose head-fin consists of but one ray, and the tail rays are carinated. It is called the *Unicorn-fish* by Catesby, and is found in the Asiatic and American seas. 2. The hispidus, whose head-fin is uniradiated; and there is a round black spot in the tail-fin. The body is rough and bristly towards the tail. The spine or horn is situated between the eyes; the snout is subulated; and instead of a belly-fin, it has a jagged sharp spine. This species is a native of Carolina. 3. The tomentosus, whose head-fin is biradiated, and the body of it towards the hind-part is hairy. It is a native of America. 4. The papillosus, has a biradiated back-fin, and a papilous body. 5. The verrucosus, has a triradiated back-fin; and the tail is full of little warts. In place of a belly-fin this species has a large, thick, warty ray. It has 25 small reversed sharp spines at the side of the tail, disposed in four rows. It is a native of India. 6. The aculeatus has a triradiated back-fin; and the spines of the tail lean upon each other. It is also a native of India. 7. The vetula, has a triradiated back-fin; the belly-fin is longitudinal,

tudinal, and somewhat carinated; and the tail-fin is forked. It is found at Ascension Island. 8. The ringens, has a triradiated back-fin; there are three folds on each side of the head, and the tail-fin is forked. This species is likewise found at Ascension Island.

**BALIVO** *amovendo*, in law, was a writ for removing a bailiff from his office, for want of having sufficient land in his bailiwick to answer the king and his people, according to the statute of Westminster, 2 reg. Orig. 78.

**BALK**, among builders, is sometimes used for the summer-beam of a house; sometimes for the poles and rafters, which support the roofs of barns, &c.; and sometimes for the beams used in making sea-holds.

**BALK**, in agriculture, denotes a ridge, or bank between two furrows.

**BALKE**, or **BALKHE**, a city of Asia, in the Ubec Tartary, situated upon the river Dilhas, in 68° E. lon. and 36° 40' N. lat.

**BALL**, in a general sense, a spherical and round body, whether it be so naturally, or turned into that figure by the hand of an artist: Thus we say, a tennis-ball, foot-ball, cotton-ball, &c.

**BALL**, in the military art, comprehends all sorts of bullets for fire-arms, from the cannon to the pistol. See **GUNNERY**.

Cannon-balls are of iron; musquet-balls, pistol-balls, &c. are of lead. The experiment has been tried of iron balls for pistols and fuses, but they are justly rejected, not only on account of their lightness, which prevents them from flying strait, but because they are apt to furrow the barrel.

**BALL and socket** is an instrument made of brass, with a perpetual screw, so as to move horizontally, vertically, and obliquely; and is generally used for the managing of surveying, and astronomical instruments.

• **BALL of a pendulum**, the same with bob. See **BOB**.

**BALL**, among printers. See **PRINTING**.

**Puff-BALL**, the English name of the lycoperdon. See **LYCOPERDON**.

**BALLAD**, or **BALLET**, a kind of song, adapted to the capacity of the lower class of people; who, being mightily taken with this species of poetry, are thereby not a little influenced in the conduct of their lives. Hence we find, that seditious and designing men never fail to spread ballads among the people, with a view to gain them over to their side.

**BALLANCE**, or **BALANCE**, in mechanics, one of the simple powers, which serves to find out the equality or difference of weight in heavy bodies. See **MECHANICS**.

*Hydrostatical BALLANCE*. See **HYDROSTATICS**.

**BALLANCE of trade**, in commerce, the equality between the value of the commodities bought of foreigners, and the value of the native productions transported into other nations. See **COMMERCE**.

• **BALLANCE of a clock**, or *watch*. See **CLOCK** and **WATCH MAKING**.

**BALLANCE fish**. See **SQUALUS**.

**BALLANCER**, in the history of insects, a style, or oblong body, ending in a protuberance or head, found

under each wing of the two-winged flies; these serve to poise the body of the fly.

**BALLAST**, a quantity of stones, gravel, or sand, laid in a ship's hold, to make her sink to a certain depth into the water, and sail upright. The ballast is sometimes one quarter, one third, or one half, according to the difference of the bulk of the ship. Flat vessels require the most ballast. Ships are said to be in ballast, when they have no other loading. Masters of vessels are obliged to declare the quantity of ballast they bear, and to unload it at certain places. They are prohibited unloading their ballast in havens, roads, &c. the neglect of which has ruined many excellent ports.

**BALLASTAGE**, or **LASTAGE**. See **LASTAGE**.

**BALLERUS**, in ichthyology, the trivial name of a species of cyprinus. See **CYPRINUS**.

**BALLET**. See **BALLAD**.

**BALLIAGE**, or **BAILIAGE**. See **BAILIAGE**.

**BALLICONNEL**, a town of Ireland, about 11 miles north-east of Cavan, 7° 50' W. long. 54° 6' N. lat.

**BALLIMORE**, a town of Leinster in Ireland, surrounded entirely with a marsh.

**BALLISHANNON**, a large town of the county of Donegal, and province of Ulster in Ireland, situated about ten miles south of the town of Donegal, in 8° 30' W. long. and 54° 25' N. lat.

**BALLISTA**, in antiquity, a military machine used by the ancients in besieging cities, to throw large stones, darts, and javelins.

It resembled our cross-bows, though much larger and superior in force.

From this engine, stones of a size not less than mill-stones, were thrown with so much violence, as to dash whole houses in pieces at a blow. It is described thus: A round iron cylinder was fastened between two planks, from which reached a hollow square beam, placed cross-wise, and fastened with cords, to which were added screws; at one end of this stood the ingineer, who put a wooden shaft with a big head into the cavity of the beam; this done, two men bent the engine by drawing some wheels: When the top of the head was drawn to the outmost end of the cords, the shaft was driven out of the ballista, &c.

**BALLISTES**, in ichthyology. See **BALISTES**.

**BALLOON**, or **BALLON**, in a general sense, signifies any spherical hollow body, of whatever matter it be composed, or for whatever purposes it be designed. Thus, with chemists, balloon denotes a round short-necked vessel, used to receive what is distilled by means of fire; in architecture, a round globe on the top of a pillar; and among engineers, a kind of bomb made of paste-board, and played off in fire-works, either in the air or on the water, in imitation of a real bomb.

Balloon, in the French paper trade, is a term for a quantity of paper, containing 24 reams. It is also the name of a sort of brigantine used in the kingdom of Siam.

**BALLON**, in geography, a town of France, in the diocese of Mans, upon the banks of the Orne, 50' E. lon. 48° 10' N. lat.

**BALLOTA**,

- BALLOTA**, in botany, a genus of the didynamia gymnospermia class. The calix has four teeth; the superior lip of the corolla is concave and crenated. There are four species, *viz.* the nigra, or stinking horehound, a native of Britain; the alba and lanata, both natives of Europe; and the suaveolens, a native of America.
- BALLOTADE**, in the menage, the leap of a horse between two pillars, or upon a straight line, made with justness of time, with the aid of the hand, and the calves of the legs; and in such a manner, that when his fore-feet are in the air, he shews nothing but the shoes of his hinder-feet without jerking out.
- BALLS**, or **BALLETS**, in heraldry, a frequent bearing in coats of arms, usually denominated according to their colours, bezants, plates, hurts, &c. See **BEZANTS**.
- BALLUSTER**, a small kind of pillar used for ballustrades. See **ARCHITECTURE**.
- BALLUSTRADE**, a series or row of ballusters, joined by a rail; serving as well for a rest to the elbows, as for a fence or inclosure to balconies, altars, staircases, &c. See **ARCHITECTURE**.
- BALM**, in botany. See **MELISSA**.
- BALM**, or **BALSAM**. See **BALSAM**.
- BALNEUM**, a term used by chemists to signify a vessel filled with some matter, as sand, water, or the like, in which another is placed that requires a more gentle heat than the naked fire. Thus *balneum arenosum*, called also *balneum siccum*, and sand-heat, is when the cucurbit is placed in sand, in ashes, or filings of steel. *Balneum marie*, or *maris*, is when the vessel, containing the ingredients to be distilled, &c. is put into a vessel of water, which is made to boil; so that no greater heat than that of boiling water can be communicated to the substance to be treated. And *balneum vaporis*, or *vaporarium*, is, when two vessels are disposed in such a manner, that the vapour, raised from the water contained in the lower, heats the matter contained in the upper.
- BALOTADE**, or **BALLOTADE**. See **BALLOTADE**.
- BALOWA**, a city of Asia, in the kingdom of Decan.
- BALSAM**, or **NATIVE BALSAM**, an oily, resinous, liquid substance, flowing either spontaneously, or by means of incision, from certain plants. There are a great variety of balsams, generally denominated from the substances from which they are obtained. See **CHEMISTRY**, *Of resins and balsams*.
- BALSAMICS**, in pharmacy, softening, restoring, healing and cleansing medicines, of a gentle attenuating nature.
- Balsamics may be used, both internally and externally, in all diseases of the head, nerves, stomach, &c.
- BALSAMINA**, in botany, the trivial name of a species of impatiens. See **IMPATIENS**.
- BALSAMITA**, in botany, a synonyme of a species of xeranthemum. See **XERANTHEMUM**.
- BALSARA**, in geography, the same with Bassora. See **BASSORA**.
- BALTIC sea**, that lying between Sweden on the north, and Germany and Livonia on the south.
- BALTIMORE**, a town of the county of Corke, and province of Munster, in Ireland, situated about five miles north of Cape Clear, in  $9^{\circ} 15'$  W. long. and  $51^{\circ} 15'$  N. lat.
- BALZANE**. See **WHITEFOOT**.
- BAMBERG**, a city of Franconia, in Germany,  $10^{\circ} 50'$  E. long. and  $50^{\circ} 15'$  N. lat.
- The bishop of Bamberg is sovereign of the city and district round it, for sixty miles in length, and forty in breadth.
- BAMBOE**, in botany, the trivial name of a species of arundo. See **ARUNDO**.
- BAMFF**, or **BANFF**, a town of Scotland, which gives name to a county, lying between Aberdeenshire and Murray, along the southern bank of the river Spey.
- The town is situated at the mouth of the river Dovern.
- BAMPTON**, a market-town of Oxfordshire, situated on the river Isis, about ten miles south-west of Oxford,  $1^{\circ} 35'$  W. long. and  $51^{\circ} 40'$  N. lat.
- BAMPTON** is also the name of a market-town in Devonshire, twenty miles north of Exeter, in  $3^{\circ} 40'$  W. long. and  $51^{\circ} 5'$  N. lat.
- BAN**, or **BANN**. See **BANN**.
- BAN**, in commerce, a sort of smooth, fine mullin, which the English import from the E. Indies. The piece is almost a yard broad, and runs about twenty yards and a half.
- BANBURY**, a large borough-town in Oxfordshire, twenty miles north of Oxford, in  $1^{\circ} 20'$  W. long. and  $52^{\circ} 5'$  N. lat.
- BANC**, or **BENCH**, in law, denotes a tribunal, or judgment-seat: Hence, king's-banc is the same with the court of king's-bench, and common banc with that of common pleas. See **KING'S BENCH** and **COMMON PLEAS**.
- BANCA**, an island of the E. Indies, separated from the south-east part of that of Sumatra by a very narrow channel, in  $105^{\circ}$  E. long. and  $3^{\circ}$  S. lat.
- BANCALIS**, a sea-port town on the east coast of Sumatra, in  $99^{\circ}$  E. long. and  $2^{\circ}$  N. lat. It is a Dutch settlement.
- BANCOCK**, a city of the kingdom of Siam, in  $101^{\circ}$  E. long. and  $13^{\circ} 30'$  N. lat.
- BAND**, in a general sense, some small, narrow ligament, wherewith any thing is bound, tied, or fastened.
- BAND**, in architecture, a general name for any flat, low member, or moulding, that is broad, but not very deep.
- BAND of soldiers**, in military affairs, those who fight under the same flag or ensign.
- Trained BANDS**. See **TRAINED bands**.
- BAND of pensioners** are a company of 120 gentlemen, who receive a yearly allowance of a hundred pounds for attending on his majesty on solemn occasions.
- BAND** is also the denomination of a military order in Spain, instituted by Alphonfus XI. king of Castile, for the younger sons of the nobility; who, before their admission, must serve ten years, at least, either

- in the army. or at court; and are bound to take up arms for the catholic faith against the infidels.
- BAND**, in surgery, a fillet, swath, or piece of linen cloth, wherewith either to cover or surround certain parts that stand in need of assistance; and is, in this sense, the same with what is otherwise called a *roller*.
- BANDA**, or **LANTOR**, the chief of the Banda islands in the E. Indies, where nutmegs grow, in  $128^{\circ}$  E. long. and  $4^{\circ} 30'$  S lat.
- BANDAGE**, in surgery, a fillet, roller, or swath, used in dressing and binding up wounds, restraining dangerous hæmorrhages, and in joining fractured and dislocated bones. See **SURGERY**.
- BANDALEER**, or **BANDELEER**, in military affairs, a large leathern belt, thrown over the right shoulder, and hanging under the left arm; worn by the ancient musqueteers, both for the sustaining of their fire-arms, and for the carriage of their musquet-charges, which being put up in little wooden cases, coated with leather, were hung, to the number of twelve, to each bandcleer.
- BANDELET**, or **BANDLET**, in architecture, any little band, or flat moulding, as that which crowns the Doric architrave.
- BANDER-ABASSI**, in geography. See the article **GOMBRON**.
- BANDER-CONGO**, a sea-port town on the eastern side of the Persian gulf: E. long.  $54^{\circ} 50'$ , and N. lat.  $27^{\circ}$ .
- BANDERET**, a general, or one of the commanders in chief of the forces.
- This appellation is given to the principal commanders of the troops of the canton of Bern in Switzerland, where there are four banderets, who command all the forces of that canton.
- BANDEROLL**, a little flag, in form of a guidon, extended more in length than breadth, used to be hung out on the masts of vessels, &c.
- BANDITTI**, a term peculiarly denoting companies of highwaymen, common in Italy and France; but sometimes also used in a more general sense, for robbers, pirates, out-lawed persons, ruffians, &c.
- BANDO**, the same with **ASMER**. See **ASMER**.
- BANDORA**, the capital of the island of Salfet, or Cononin, on the west coast of the Hither India: E. long.  $72^{\circ} 30'$ , and N. lat.  $19^{\circ}$ .
- BANDORA** is also the name of an ancient musical instrument, with strings, resembling a lute. See **LUTE**.
- BANGLE ears**, an imperfection in a horse, remedied in the following manner. Place his ears in such a manner as you would have them stand; bind them with two little boards so fast that they cannot stir, and then clip away all the empty wrinkled skin close by the head.
- BANDY-LEGGED persons** are such whose feet are distorted, turning either inward or outward on either side.
- BANGOR**, a city of Carnarvonshire, in North Wales: W. long.  $4^{\circ} 15'$ , and N. lat.  $53^{\circ} 20'$ .
- It is a bishop's see, and situated on the sea-side, about 30 miles west of St Asaph.
- BANGUE**, or **BEND**. See **BEND**.
- BANIALUCH**, or **BAGNALUCH**, a city of European Turkey, the capital of Bosnia, upon the frontiers of Dalmatia, near the river Setina: E. long.  $18^{\circ} 20'$ , N. lat.  $44^{\circ} 20'$ .
- BANIANA**, a city of India, upon the road from Surat to Agra.
- BANIANS**, a religious sect in the empire of the Mogul, who believe a metempsychosis; and will therefore eat no living creature, nor kill even noxious animals; but endeavour to release them, when in the hands of others.
- BANJAR**, a river in the island of Borneo, in the mouth of which is a floating island, where the East-India company have a factory.
- BANILLA**, or **VANILLA**. See **VANILLA**.
- BANISHMENT**, a kind of punishment, whereby the guilty person is obliged to leave the realm.
- BANK**, in commerce, a common repository, where many persons agree to keep their money, to be always ready at their call or direction; or certain societies or communities, who take the charge of other peoples money, either to improve it, or to keep it secure.
- There are banks of various kinds, and different in the nature of their constitutions and establishments: Some are instituted wholly on the public account, and put under the direction of the magistrates, as the famous bank of Amsterdam, where the money deposited therein shall be always kept for the use of the proprietors, and shall never be let out for profit or advantage.
- Payments made by assignments upon this bank, are valued from 3 to 6 *per cent.* above the payment of the money in specie, arising from an opinion that the proprietors entertain of the equity of its administration; for judging themselves secure, that their money lies always ready at hand, they seldom draw out large sums, but make their mutual payments by transferring the sums from one man's account to another.
- A second sort of bank, is such as consists of a company of monied men, who being duly established, and incorporated by the laws of their country, agree to deposit a considerable fund, or joint stock, to be employed for the use of the society; as lending money upon good security, buying and selling bullion, gold and silver, discounting bills of exchange, &c.
- A third sort, is the banks of private men, or partnerships, who deal in the same way as the former, upon their own single stock or credit. There are public banks established in most of the trading cities of Europe, as in Venice, London, Paris, Amsterdam, Hamburg, &c. The bank of Venice is the most ancient. It is established by a solemn edict of the commonwealth, which enacts, That all payments of wholesale merchandise, and letters of exchange, shall be in bank-notes; that all debtors shall be obliged to carry their money to the bank, and all creditors receive their money from the bank; so that payments are performed by a simple transfer from the one person to the other. In matters of retail, effective payments are sometimes made, which do not diminish, but rather augment

- augment the stock, by reason of the liberty of withdrawing their money at pleasure, &c.
- BANKAFLET**, a game at cards, which being cut into as many heaps as there are players, every man lays as much money on his own card as he pleases; and the dealer wins or looses as many as his card is superior or inferior to those of the other gamers.
- The best card is the ace of diamonds; the next to it, the ace of hearts; then the ace of clubs; and, lastly, the ace of spades: And so of the rest of these suits in order, according to their degree.
- The cheat lies in securing an ace, or any other sure winning card; which are somehow marked, that the sharper may know them.
- BANKER**, a person who traffics and negotiates in money; who receives and remits money from place to place by commission from correspondents, or by means of bills or letters of exchange.
- BANKISH**, a province of the Mogul's dominions, in the north part of the Hither India, lying south west of the province of Cassimere.
- Commission of BANKRUPTCY.* See **COMMISSION.**
- BANN**, or **BAN**, in the feudal law, a solemn proclamation or publication of any thing. Hence the custom of asking, or bans, before marriage. See **MARRIAGE.**
- BANN**, in military affairs, a proclamation made in the army by beat of drum, sound of trumpet, &c. requiring the strict observance of discipline, either for the declaring a new officer, or punishing an offender.
- BANN** of the empire, an imperial proscription, being a judicial punishment, wherewith such as are accessory to disturbing the public peace are judged unworthy of the immunities and protection of the empire, and are outlawed or banished, &c.
- BANNAGHER**, a town of Ireland, in the king's county, and province of Leinster, situated on the river Shannon, 8° W. long. and 53° 10' N. lat.
- BANNER** denotes either a square flag, or the principal standard belonging to a prince.
- BANNERET**, an ancient order of knights, or feudal lords, who, possessing several large fees, led their vassals to battle under their own flag, when summoned thereto by the king.
- BANNISTERIA**, in botany, a genus of the decandria trigynia class. The calix is divided into 5 parts, with a nectarium at the base of each; the petals are roundish and unguiculated; the capsule contains 3 membranaceous alated seeds. The species are 7, all natives of America.
- BANNIMUS**, the form of expulsion of any member from the university of Oxford, by affixing the sentence up in some public place, as a denunciation of it.
- BANNOCK**, a kind of oat-cake, baked in the embers, or on a stone placed before the fire: It is common in the northern parts of this kingdom.
- BANNUM**, in law, signifies the utmost bounds of a manor or town.
- BANQUET**, a feast or entertainment, where people regale themselves with pleasant foods, or fruits. It signifies also a little bank, or raised way.
- BANQUET**, in the menage, that small part of the branch of a bridle that is under the eye, which being rounded like a small rod, gathers and joins the extremities of the bitt to the branch, and that in such a manner, that the banquet is not seen, but covered by the cope, or that part of the bitt that is next the branch.
- BANQUET-line**, an imaginary line drawn, in making a bitt, along the banquet, and prolonged up or down, to adjust the designed force or weakness of the branch, in order to make it stiff or easy.
- BANQUET**, or **BANQUETTE**, in fortification, a little foot-bank, or elevation of earth, forming a path, which runs along the inside of a parapet, upon which the musqueteers get up, in order to discover the counter-scarp, or to fire on the enemy in the moat, or in the covert-way.
- BANSTICLE**, in ichthyology. See **GASTEROSTEUS.**
- BANTAM**, the capital of a large kingdom, and a port-town of great trade, situated on the north-west coast of the island of Java, in 105° E. long. and 6° 30' S. lat.
- BANTAM-work**, a kind of painted or carved work, resembling that of Japan, only more gaudy.
- BANTON**, in geography, one of the Philippine islands.
- BANTRY**, a town of Ireland, situated on a bay of the same name, in the county of Cork, and province of Munster, in 9° 20' W. long. and 51° 30' N. lat.
- BANZA**, a city of Africa, the capital of the kingdom of Congo.
- BAPAUME**, a fortified town of the French Netherlands, about 12 miles south-east of Arras, in 3° E. long. and 50° 10' N. lat.
- BAPTISM**, in matters of religion, a sacrament, by which a person is initiated into the Christian church. See **RELIGION.**
- BAPTISM**, in the sea-language, a ceremony in long voyages on board merchant-ships, practised both on persons and vessels who pass the tropic or line for the first time. The baptizing the vessel is simple, and consists only in washing them throughout with sea-water; that of the passengers is more mysterious: The oldest of the crew, that has past the tropic or line, comes with his face blacked, a grotesque cap on his head, and some sea-book in his hand, followed by the rest of the sea-men dressed like himself, each having some kitchen-utensil in his hand, with drums beating. He places himself on a seat on the deck, at the foot of the main mast. At the tribunal of this mock magistrate, each passenger not yet initiated, swears he will take care the same ceremony be observed, whenever he is in the like circumstances: Then by giving a little money by way of gratification, he is discharged with a little sprinkling of water, otherwise he is heartily drenched with streams of water poured upon him; and the ship-boys are inclosed in a cage, and ducked at discretion.
- The seamen, on the baptizing a ship, pretend to a right of cutting off the beak-head, unless redeemed by the captain.

**BAPTISMAL**, something belonging to baptism; thus, we say, *baptismal vow, fonts, presents, &c.*

**BAPTISTS**, in church-history, the name by which the Anabaptists love to distinguish themselves. See **ANABAPTISTS**.

**BAPTISTERY**, in ecclesiastical writers, a place in which the ceremony of baptism is performed. In the ancient church, it was one of the *exedrae*, or buildings, distinct from the church itself, and consisted of a porch or anti-room, where the persons to be baptized made their confession of faith; and an inner room where the ceremony of baptism was performed.

**BAR**, in a general sense, denotes a slender piece of wood, or iron, for keeping things close together.

**BAR**, in courts of justice, an inclosure made with a strong partition of timber, where the council are placed to plead causes. It is also applied to the benches where the lawyers or advocates are seated, because anciently there was a bar to separate the pleaders from the attorneys and others. Hence our lawyers, who are called to the bar, or licensed to plead, are termed *bar-riters*, an appellation equivalent to licentiate in other countries.

**BAR**, in law, a plea of a defendant, which is said to be sufficient to destroy the plaintiff's action.

**BAR**, in heraldry, an ordinary in form of the fess, but much less.

It differs from the fess only in its narrowness; and in this, that the bar may be placed in any part of the field, whereas the fess is confined to a single place. See Plate LI. fig. 4.

*Bar-gemel*, that is a double bar, called by the French *jumelles*, and by the Latin writers *jugaria fasciola*, and *justitiae bijuges*, is a diminutive of the fess. See Plate LI. fig. 5.

**BAR**, in the menage, the highest part of that place of a horse's mouth, situated between the grinders and tusks; so that the part of the mouth which lies under and at the side of the bars, retains the name of the gum. A horse with sensible bars has a fine light mouth, with an even and firm appui. See **APPUI**.

*To BAR a vein*, in farriery, is an operation performed upon the veins of the legs of a horse and other parts, with intent to stop the malignant humours. It is done by opening the skin above it, disengaging it, and tying it both above and below, and striking between the two ligatures.

**BAR**, in music, a stroke drawn perpendicularly across the lines of a piece of music, including between each two a certain quantity or measure of time, which is various as the time of the music is either triple or common. In common time, between each two bars is included the measure of four crotchets; in triple, three. The principal use of bars is to regulate the beating of time, in a concert. See **TIME** and **MEASURE**.

**BAR**, in hydrography, denotes a bank of sand, or other matter, whereby the mouth of a river is in a manner choked up.

The term bar is also used for the strong beam wherewith the entrance of an harbour is secured: This is more commonly called boom.

**BAR, BARRA**, in commerce. See **BARRA**.

**BAR, or BAR-LE-DUC**, in geography, a duchy belonging to France, lying north-west of Lorraine, on both sides the river Maese, whereof Bar-le-duc is the principal town; in  $5^{\circ} 15'$  E. long. and  $48^{\circ} 40'$  N. lat.

**BAR** is also a town of Podolia, in Poland; situated in  $28^{\circ}$  E. long. and  $48^{\circ} 20'$  N. lat.

**BAR** is also the name of two towns in France; the one in Champaign, upon the Aube; and the other in Burgundy, upon the Seine.

**BARABINSKOI**, a country of Tartary, tributary to the Muscovites.

**BAR-MASTER**, among miners, the person who keeps the gage, or dish, for measuring the ore.

**BAR-SHOT**. See **SHOT**.

**BARACKS, or BARRACKS**. See **BARRACKS**.

**BARACOA**, a town on the north-east part of the island of Cuba in North America, in  $76^{\circ}$  W. long. and  $21^{\circ}$  N. lat.

**BARALIPTON**, among logicians, a term denoting the first indirect mode of the first figure of syllogism. A syllogism in baralipon, is when the two first propositions are general, and the third particular, the middle term being the subject in the first proposition, and the predicate in the second.

**BARALLOTS**, in church-history, a sect of heretics at Bologna in Italy, who had all things in common, even their wives and children.

Their facility in complying with all manner of debauchery, made them get the name *obedientes*, compliers.

**BARANCA**, a port-town of Terra Firma, in South America; situated about 30 miles up the river Grande, in  $75^{\circ} 30'$  W. long. and  $11^{\circ}$  N. lat.

**BARANGI**, officers among the Greeks of the lower empire. Cujas calls them in Latin *protectores*, and others give them the name of *securigeri*. It was their business to keep the keys of the city-gates, where the emperor resided.

**BARANWAHR**, a town of Lower Hungary, not far from the Danube, in  $20^{\circ}$  E. long. and  $46^{\circ} 20'$  N. lat.

**BARAPICKLET**, bread made of fine flour, and kneaded up with barm, which makes it very light and spongy. Its form is round, about a hand-breadth.

**BARATHRUM**, in antiquity, a deep dark pit at Athens, into which condemned persons were cast headlong. It had sharp spikes at the top, that no man might escape out, and others at the bottom to pierce and torment such as were cast in.

**BARB, or BARBE**, in commerce. See **BARBE**.

**BARBA**, in botany, a word often used in composition with some other, to form the trivial names of several plants, as *barba jovis*, *barba caprae*, &c.

**BARBACAN, or BARBICAN**, an outer defence, or fortification to a city or castle, used especially as a fence to the city, or walls; also, an aperture made in the wall of a fortress, to fire through upon the enemy.

**BARBACAN** is also used to denote a fort at the entrance of a bridge, or the outlet of a city, having a double wall with towers.

**BARBALIA**, in botany, a genus of the didynamia angiospermia. The calix consists of four divisions; the capsule

capsule is quadrangular, with two elastic valves, and two seeds. There are six species, none of them natives of Britain.

**BARBACAN**, in architecture, a canal, or opening left in the wall, for water to come in and go out, when buildings are erected in places liable to be overflowed, or to drain off the water from a terrace, or the like.

**BARBADOES**, one of the British Caribbee Islands, lying eastward of all the rest, in  $59^{\circ} 30'$  W. long. and  $13^{\circ}$  N. lat. being only 25 miles in length, and about 15 in breadth.

**BARBADOES-TAR**, a mineral fluid of the nature of the thicker fluid bituminous, of a nauseous, bitterish taste, very strong and disagreeable smell, found in many parts of America trickling down the sides of the mountains, and sometimes floating on the surface of the waters. It has been greatly recommended in coughs, and other disorders of the breast and lungs.

**BARBANCON**, a principality of Hainault.

**BARBARA**, among logicians, the first mode of the first figure of syllogisms.

A syllogism in barbara, is one whereof all the propositions are universal and affirmative; the middle term being the subject of the first proposition, and attribute in the second. For example,

**BAR.** Every wicked man is miserable;

**BA.** All tyrants are wicked men;

**RA.** Therefore all tyrants are miserable.

**BARBARIAN**, a name given by the ancient Greeks and Romans to all who were not of their own country, or were not initiated in their language, manners, and customs.

In this sense the word signified with them no more than foreigner; not signifying, as among us, a wild, rude, or uncivilized person.

**BARBARISM**, in a general sense, a rudeness of language or behaviour.

**BARBARISM**, in grammar, an offence against the purity of style or language; or an ungrammatical way of speaking or writing, or contrary to the true idiom of any particular language.

**BARBARY**, a large tract of Africa, extending along the Mediterranean, from  $2^{\circ}$  W. long. to  $30^{\circ}$  E. long. that is, from the river Mulvia, which separates it from Morocco, to Egypt.

It comprehends the countries of Algiers, Tunis, Tripoli, and Barca.

**BARBASOTE**, a sea-port of Africa in the kingdom of Fez, at a little distance from Ceuta. See **CEUTA**.

**BARBE**, in commerce, a barbary horse, greatly esteemed for its beauty, strength, and swiftness. Barbies are commonly of a slim shape, and have very thin legs; they retain their vigour to the last, and are therefore much prized for stallions. They are used both for the saddle and the coach.

**BARBE**, in the military art: To fire in barbe, means to fire the cannon over the parapet, instead of firing through the embrasures; in which case the parapet must not be above three feet and a half high.

**BARBE**, or **BARDE**, is an old word, denoting the armour of the horses of the ancient knights and soldiers,

who were accoutred at all points. It is said to be an armour of iron and leather, wherewith the neck, breast, and shoulders of the horse were covered.

**BARBED**, in a general sense, bearded like a fish-hook, set with barbs; also shaved or trimmed.

**BARBED**, and **CRESTED**, in heraldry, an appellation given to the combs and gills of a cock, when particularized for being of a different tincture from the body.

A barbed cross, is a cross, the extremities whereof are like the barbed irons used for striking of fish. See Plate LI. fig. 6.

**BARBELICOTÆ**, in church-history, a sect of gnostics, who affirmed that an immortal Eon had commerce with a virgin called Barbelath, to whom he granted successively the gift of prophecy, incorruptibility, and eternal life.

**BARBER**, one who makes a trade of shaving or trimming the beards of other men for money.

**BARBERINO**, a town of Tuscany in Italy, situated upon the river Siera, in  $11^{\circ}$  E. long. and  $44^{\circ} 5'$  N. lat.

**BARBERRY**, in botany. See **BERBERIS**.

**BARBICAN**, or **BARBACAN**. See **BARBACAN**.

**BARBLE**, or **BARBEL**. See **BARBEL**.

**BARBLES**, or **BARBS**, in farriery, the knots or superfluous flesh, that grow up in the channels of a horse's mouth; that is, in the intervals that separate the bars, and lie under the tongue.

**BARBOTINE**, a seed called *semen santonicum*, & *semen contra vermes*; in English, worm-seed. See **WORM-SEED**.

**BARBORA**, a maritime city of Africa, in the kingdom of Adel, upon the streights of Babelmandel.

**BARBUDA**, one of the British Caribbee Islands, about 20 miles long, and 12 broad, in  $61^{\circ}$  W. long. and  $18^{\circ}$  N. lat.

**BARBUS**, in ichthyology. See **CYPRINUS**.

**BARBUSINSKOI**, a city of Asia, in the Russian empire, situated upon the eastern bank of the lake Baikal.

**BARBY**, a town of Upper Saxony, in Germany, upon the Elbe.

**BARBYLA**, in botany. See **PRUNUS**.

**BARCA**, a country lying on the Mediterranean, between Tripoli and Egypt; a barren desert for the most part.

**BARCALON**, an appellation given to the prime minister of the king of Siam. The barcalon has in his department every thing relating to commerce, both at home and abroad. He is likewise superintendent of the king's magazines.

**BARCELONA**, the chief city of Catalonia, in Spain. It is situated in a large plain along the shore of the Mediterranean; being divided into the new and old town, separated from each other by a wall and ditch:  $2^{\circ}$  E. long. and  $41^{\circ} 20'$  N. lat.

**BARCELONETA**, a town of Piedmont, now subject to France:  $6^{\circ} 40'$  E. long. and  $44^{\circ} 35'$  N. lat.

**BARCELOR**, or **BASSELOR**, a port-town on the coast of Malabar, in  $74^{\circ} 15'$  E. long. and  $13^{\circ} 30'$  N. lat.

**BARCELOS**, a town of the province of Entre-Minhouro, in Portugal, about 30 miles north of Porto, in  $9^{\circ} 15'$  W. long. and  $41^{\circ} 20'$  N. lat.

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BARD,

- BARD**, a poet among the ancient Gauls and Britons, who celebrated the praises of heroes, with a view to inculcate virtue, and sometimes to terminate a difference between two armies at the point of engagement. It is disputed wherein the bards differed from the druids: Some pretend that these were the priests and philosophers of the nation, and that those were only the poets and historians; but it is more probable that druid was a general word, comprehending the priests, the judges, the instructors of youth, and the bards or poets.
- BARDANA**, in botany. See **ARCTIUM**.
- BARDED**, in heraldry, the same with caparioned.
- BARDELLE**, in the menage, a saddle made in the form of a great saddle, but only of cloth stuffed with straw, and tied tight down with packthread, without either leather, wood, or iron. In Italy they trot their colts with such saddles.
- BARDESANISTS**, in church-history, Christian heretics of the second century, who maintained that the devil was a self-existent independent being; that Jesus Christ was not born of a woman, but brought his body with him from heaven; and denied the resurrection of the body.
- BARDEWICK**, a town in Lower Saxony in Germany, about seven miles north of Lunenburg. It is subject to the elector of Hanover, and situated in  $10^{\circ} 6' E.$  long. and  $53^{\circ} 40' N.$  lat.
- BARDS, BARDI**. See **BARD**.
- BARDS**, in the art of cookery, broad slices of bacon, with which pullets, capons, pigeons, &c. are sometimes covered, before they are roasted, baked, or otherwise dressed.
- BARDT**, a port-town of Pomerania, in Germany; it is subject to Sweden, and situated in  $13^{\circ} 20' E.$  long. and  $54^{\circ} 20' N.$  lat.
- BARREITH**, a town of Franconia in Germany, &c. in the margraviate of Culbach; in  $12^{\circ} 20' E.$  long. and  $50^{\circ} N.$  lat.
- BARENTON**, a town of lower Normandy in France.
- BAR-FEE**, a fee of twenty pence which every prisoner acquitted of felony pays to the goaler.
- BARFLEUR**, a town and cape of Normandy, in France, about 12 miles east of Cherbourg; in  $1^{\circ} 15' W.$  and  $49^{\circ} 47' N.$  lat.
- BARGE**, in naval affairs, a boat of state and pleasure, adorned with various ornaments, having bales and tilts, and seats covered with cushions and carpets, and benches for many oars; as the lord-mayor's barge, a company's barge, an admiral's barge, &c. It is also the name of a flat-bottomed vessel employed for carrying goods in a navigable river; as those upon the river Thames, called *west-country barges*.
- BARGE**, in ornithology. See **SCOLOPAX**.
- BARGE-couples**, in architecture, a beam mortised into another, to strengthen the building.
- BARGE-course**, with bricklayers, a term used for that part of the tiling which projects over without the principal rafters, in all sorts of buildings, where there is either a gable or a kirkin-head. See **GABLE** and **HEAD**.
- BARGEMONT**, a town of Provence in France, in the diocese of Frejus.
- BARILLIA**, a kind of Spanish pot-ash, used in the glass-trade.
- BARING of trees**, in agriculture, the taking away some of the earth about the roots, that the winter-rain and snow-water may penetrate further into the roots. This is frequently practised in the autumn.
- BARJOLS**, a town of Provence in France, in  $6^{\circ} 50' E.$  long. and  $43^{\circ} 36' N.$  lat.
- BARIPICNI**, or **SUONI BARIPICNI**, in music, signify in general any low, grave, or deep sound.
- BARK**, in the anatomy of plants, the exterior part of trees, corresponding to the skin of an animal. See **AGRICULTURE**, p. 43.
- BARK**, or **JESUIT'S BARK**, is a name given by way of eminence to the quinquina. See **QUINQUINA**.
- BARK**, in navigation, a little vessel with two or three triangular sails; but, according to Guillet, it is a vessel with three masts, *viz.* a main-mast, fore-mast, and mizen-mast. It carries about two hundred tons.
- BARKAN**, a town of Hungary, remarkable for two victories which the Christians obtained there over the Turks, the one in 1664, and the other in 1683.
- BARKARY**, a tan-house, or place for keeping bark.
- BARK-binding**, a distemper incident to trees, cured by flitting the bark, or cutting along the grain.
- BARK-galling**, is when the trees are galled with thorns, &c. It is cured by binding clay on the galled places.
- BARK-longue**, or **BARCA longa**, a small low sharp-built, but very long vessel without a deck. It goes with sails and oars, and is very common in Spain.
- BARKHAMSTEAD**, a market-town in the west part of Hertfordshire, about eighteen miles west of Hertford, in  $4' W.$  long. and  $51^{\circ} 40' N.$  lat.
- BARKING**, a fishing town of Essex, situated on the river Thames, about eight miles east of London.
- BARKING of trees**, the peeling off the rind or bark. This must be done, in our climate, in the month of May, because at that time the sap of the tree separates the bark from the wood. It would be very difficult to perform it at any other time of the year, unless the season was extremely wet and rainy, for heat and dryness are a very great hinderance to it.
- BARKLEY**, a market-town of Gloucestershire, about fifteen miles south-west of Gloucester, in  $2^{\circ} 35' W.$  lon. and  $51^{\circ} 40' N.$  lat.
- BARKWAY**, a market-town in Hertfordshire, under the meridian of London, and fifteen miles south of Cambridge.
- BARLEDUC**, the capital of the duchy of Bar. See **BAR**.
- BARLEMONT**, a town of Hainault, in the French Netherlands, situated on the river Sambre, about fifteen miles south of Mons, in  $3^{\circ} 40' E.$  long. and  $50^{\circ} 10' N.$  lat.
- BARLETTA**, a port-town of Barri, in the kingdom of Naples, situated on the gulf of Venice, twenty-two miles west of Barri, in  $17^{\circ} E.$  long. and  $41^{\circ} N.$  lat.
- BARLEY**, in botany. See **HORDEUM**.

BARLEY-



**BARLEY-corn**, the least of our long-measures, being the third of an inch.

**BARLOVENTO Isles**, the same with the Caribbees.

**BARM**, the same with yeast. See **YEAST**.

**BARNABITES**, a religious order, founded in the sixteenth century by three Italian gentlemen, who had been advised by a famous preacher of those days to read carefully the epistles of St Paul. Hence they were called *clerks of St Paul*, and *Barnabites*, because they performed their first exercise in a church of St Barnabas at Milan. Their habit is black, and their office is to instruct, catherhise, and serve in mission.

**BARNACLE**, in ornithology, a species of goose. See **ANAS**.

**BARNACLES**, in farriery, an instrument composed of two branches joined at one end with a hinge, to put upon horses noses when they will not stand quietly to be shod, blooded, or dressed.

**BARNARD-CASTLE**, a town of the bishopric of Durham, in  $1^{\circ} 3' W.$  long. and  $54^{\circ} 26' N.$  lat.

**BARNET**, a market-town of Middlesex (part of it in Hertfordshire) ten miles north-west of London, in  $10^{\circ} W.$  long. and  $51^{\circ} 42' N.$  lat.

**BARNSTABLE**, a port-town of Devonshire, situated on the river Tan, about thirty miles north of Exeter, in  $W.$  long.  $4^{\circ} 10'$ , and  $51^{\circ} 42' N.$  lat.. It sends two members to parliament.

**BAROCHE**, a port-town of the hither India, in the province of Cambaya; situated sixty miles north of Surat, in  $72^{\circ} 5' E.$  long. and  $22^{\circ} 15' N.$  lat.

**BAROCO**, in logic, a term given to the fourth mode of the second figure of syllogisms. A syllogism in baroco has the first proposition universal and affirmative, but the second and third particular and negative, and the middle term is the predicate in the two first propositions. For example,

*Nullus homo non est bipes :*

*Non omne animal est bipes :*

*Non omne animal est homo.*

**BAROMETER**, a machine for measuring the weight of the atmosphere, and the variations therein, in order to determine the changes of the weather. See **PNEUMATICS**.

**BARON**, a degree of nobility next below a viscount, and above a baronet. It is probable that formerly all those were barons who had lordships with courts-baron, and soon after the conquest all such sat in the house of peers; but they being very numerous, it grew an order and custom, that none should sit but such as the king thought fit to call up by writ, which ran *pro hac vice tantum*. This state of nobility being very precarious, they at length obtained of the king letters patent; and these were called *barons by patent*, or *creation*, the only way now in use of making barons, unless when the son of a lord, in his ancestor's life-time, is summoned by a writ.

On solemn occasions, barons wear a coronet, represented in Plate LI. fig. 19.

**BARON by tenure**, one who held certain territories of the king, who still retained the tenure in chief to himself.

**BARONS of the exchequer**, the four judges to whom the

administration of justice is committed, in causes between the king and his subjects, relating to matters concerning the revenue. They were formerly persons of the realm, but of late are generally persons learned in the laws. Their office is also to look into the accounts of the king, for which reason they have auditors under them. See **AUDITOR**.

**BARONS of the cinque-ports** are members of the house of commons, elected by the five ports, two for each port. See the article **CINQUE-PORTS**.

**BARON and FEME**, in our law, a term used for the husband in relation to his wife, who is called *feme*; and they are deemed but one person; so that a wife cannot be witness for or against her husband, nor he for or against his wife, except in cases of high treason.

**BARON and FEME**, in heraldry, is when the coats of arms of a man and his wife are borne per pale in the same escutcheon, the man's being always on the dexter side, and the woman's on the sinister; but here the woman is supposed not an heiress, for then her coat must be borne by the husband on an escutcheon of pretence. See **PALE** and **ESCUTCHEON of pretence**.

*Prendre de BARON*. See **PRENDRE**.

**BARONET**, a modern degree of honour, next to a baron, created by K. James I. in order to propagate a plantation in Ulster in Ireland, for which purpose each of them was to maintain thirty soldiers in Ireland, for three years, after the rate of eight-pence sterling per day to each soldier. The honour is hereditary, and they have the precedence of all knights, except those of the garter, bannerets, and privy-counsellors. They are styled *baronets* in all writs, and the addition of *Sir* is attributed to them, as the title of *Lady* is to their wives. No honour is created between barons and baronets.

**BARONY**, the honour and territory which gives title to a baron, whether he be a layman or a bishop.

**BAROSCOPE**, the same with barometer. See **BAROMETER**.

**BARR**, or **BAR**. See **BAR**.

**BARR-dice**, false dice, so contrived as not readily to turn up certain sides.

**BARRA**, in commerce, a long-measure used in Portugal and some parts of Spain, to measure woolen cloths, linen cloths, and serges. There are three sorts, the barra of Valencia, 13 of which make  $12\frac{7}{8}$  yards English measure; the barra of Castile, 7 of which make  $6\frac{1}{2}$  yards; and the barra of Aragon, 3 of which make  $2\frac{1}{4}$  yards English.

**BARRACAN**, in commerce, a sort of stuff, not diapered, something like camblet, but of a coarser grain. It is used to make cloaks, furtouts, and such other garments, to keep off the rain.

**BARRACKS**, or **BARACKS**, places for soldiers to lodge in, especially in garrisons.

**BARRATOR**, in law, a common mover or maintainer of suits and quarrels, either in courts, or elsewhere in the country. A man cannot be adjudged a barrator for bringing any number of suits in his own right, though they are vexatious. Barrators are punished by fine and imprisonment.

BAR-

**BARRATRY**, in law, signifies the fomenting quarrels and law-suits.

**BARRATRY**, in a ship-master, is his cheating the owners. If goods delivered on ship-board, are embezzled, all the mariners ought to contribute to the satisfaction of the party that lost his goods, by the maritime law; and the cause is to be tried in the admiralty. In a case, where a ship was insured against the barratry of the master, &c. and the jury found that the ship was lost by the fraud and negligence of the master, the court agreed, that the fraud was barratry, though not named in the covenant; but that negligence was not.

**BARREAUX-Fort**, a fortress of Savoy, having Montmelian on the north, and Grenoble on the south, situated in 5° 30' E. long. and 45° N. lat.

**BARREL**, in commerce, a round vessel, extending more in length than in breadth, made of wood, in form of a little tun. See **TUN**.

It serves for holding several sorts of merchandize.

Barrel is also a measure of liquids. The English barrel, wine-measure, contains the eighth part of a tun, the fourth part of a pipe, and one half of a hog-head; that is to say, it contains thirty-one gallons and a half: A barrel, beer-measure, contains thirty-six gallons; and, ale-measure, thirty-two gallons. The barrel of beer, vinegar, or liquor preparing for vinegar, ought to contain thirty-four gallons, according to the standard of the ale quart.

**BARREL** also denotes a certain weight of several merchandizes, which differs according to the several commodities: A barrel of Essex butter weighs one hundred and six pounds; and of Suffolk butter, two hundred and fifty-six pounds. The barrel of herrings ought to contain thirty-two gallons wine measure, which amount to about twenty-eight gallons old standard, containing about a thousand herrings. The barrel of salmon must contain forty-two gallons. The barrel of eels the same. The barrel of soap must weigh two hundred and fifty-six pounds.

**BARREL**, in mechanics, a term given by watch-makers to the cylinder about which the spring is wrapped: And by gun-smiths to the cylindrical tube of a gun, pistol, &c. through which the ball is discharged.

**BARREL**, in anatomy, a pretty large cavity behind the tympanum of the ear, about four or five lines deep, and five or six wide.

**Thundering BARRELS**, in the military art, are filled with bombs, grenades, and other fire-works, to be rolled down a breach.

**BARRENNESS**, the same with sterility. See **STERILITY**.

**BARRERA**, in botany, a genus of the pentandria pentagynia class. The calix has five divisions, and the petals five, with long filiform claws. There is but one species, viz. the capensis, a native of Æthiopia.

**BARRI**, a city of the kingdom of Naples, and capital of a province of the same name, situated on the gulf of Venice, in 17° 40' E. long. and 40° 40' N. lat.

**BARRICADE**, a warlike defence, consisting of empty barrels and such like vessels, filled with earth, stones, carts, trees cut down, against an enemy's shot, or as-

fault; but generally trees cut with six faces, which are crossed with battoons as long as a half-pike, bound about with iron at the feet.

**BARRIER**, in fortification, a kind of fence made at a passage, retrenchment, &c. to stop up the entry thereof, and is composed of great stakes, about four or five feet high, placed at the distance of eight or ten feet from one another, with transoms, or over-thwart rafters, to stop either horse or foot, that would enter or rush in with violence: In the middle is a moveable bar of wood, that opens and shuts at pleasure. A barrier is commonly set up in a void space, between the citadel and the town, in half moons, &c.

**BARRIER** has been also used to signify a martial exercise of armed men, fighting together with swords, within rails or bars, which inclosed them.

**BARRING a vein**, in farriery, an operation performed upon the veins of a horse's legs, and other parts of his body, with intent to stop the course, and lessen the quantity of the malignant humours that prevail there.

**BARRISTER**, in common law, a person qualified, and empowered to plead and defend the cause of clients, in the courts of justice. They are of two sorts, the outward, or outer-barristers, who, by their long study in and knowledge of the law, which must be for a term of seven years at least, are called to public practice, and always plead without the bar.

The inner-barristers are those, who, because they are either attorney, solicitor, serjeant, or council to the king, are allowed, out of respect, the privilege of pleading within the bar. But at the rolls, and some other inferior courts, all barristers are admitted within the bar.

Barristers, in the English laws, amount to the same with licentiates and advocatés in other countries, and courts, where the civil, &c. laws obtain.

**BARROW**, in the salt-works, wicker-cases, almost in the shape of a sugar-loaf, wherein the salt is put to drain.

**BARRULET**, in heraldry, the fourth part of the bar, or the one half of the clofset: An usual bearing in coat-armour.

**BARRULY**, in heraldry, is when the field is divided bar-ways, that is across from side to side, into several parts. See Plate LI. fig. 7.

**BARRY**, in heraldry, is when an escutcheon is divided bar-ways, that is, across from side to side, into an even number of partitions, consisting of two or more tinctures, interchangeably disposed: It is to be expressed in the blazon by the word *barry*, and the number of pieces must be specified; but if the divisions be odd, the field must be first named, and the number of bars expressed.

**BARRY-BENDY** is when an escutcheon is divided evenly, bar and bend-ways, by lines drawn transverse and diagonal, interchangeably varying the tinctures of which it consists. See Plate LI. fig. 8.

**BARRY-PILY** is when a coat is divided by several lines drawn obliquely from side to side, where they form acute angles.

**BARTER**, or **TRUCK**, is the exchanging of one commodity

modity for another; in doing of which the price of one of the commodities, and an equivalent quantity of the other, must be found either by practice, or by the rule of three.

*Quest.* 1. How many pounds of cotton, at 9 d. per lb. must be given in barter for 13 C. 3 Q. 14 lb. of pepper, at 2 l. 16 s. per C.?

*First,* Find the price or value of the commodity whose quantity is given, as follows.

	C. Q. lb. L. s.
	13 3 14 at 2 16
2 l.	26
16 s.	10 8
2 Q.	1 8
1 Q.	14
14 lb.	7
	L. 38 17

*Secondly,* Find how much cotton, at 9 d. per lb. 38 l. 17 s. will purchase, as under.

d. lb. L. s.  
If 9 : 1 :: 38 17

20
777
12
9)9324(

*Ans.* 1036 lb. = 9 1

If the above question be wrought decimally, the operation may stand as follows:

C. L. C.	
If 1 : 2.8 :: 13.875	
2.8	
111000	
27750	
.0375)38.8500(1036 = 9 1	<i>Ans.</i>
375000	
1350	
1125	
2250	
2250	

The value or price of the goods received and delivered in barter being always equal, it is obvious, that the product of the quantities received and delivered, multiplied into their respective rates, will be equal.

Hence arises a rule which may be used with advantage in working several questions; namely, Multiply the given quantity and rate of the one commodity, and the product divided by the rate of the other commodity quotes the quantity sought; or divided by the quantity quotes the rate.

*Quest.* 2. How many yards of linen, at 4 s. per yard, should I have in barter for 120 yards of velvet, at 15 s. 6 d.?

*Yds. Sixp. Yds.*  
120 × 31 = 3720, and 8)3720(459 *Ans.*

**BARTHOLOMEW**, or *St* BARTHOLOMEW, one of the Caribbee islands, situated in 62° 5' W. long. and 18° 6' N. lat.

**BARTON**, a market-town in Lincolnshire, situated on the southern shore of the Humber, 30 miles south-east of York, in 15' W. long. and 53° 40' N. lat.

**BARTON** is also used, in the west of England, for the demesne lands of a manor; also for the manor-house; and in some parts for out-houses, &c.

**BARTSIA**, in botany, a genus of the didymia angiospermia class. The calix has two coloured emarginated lobes; the corolla is less than the calix, and the superior lip is longest; the capsule has two cells. The species are 4, of which the viscosa, or marsh eye-bright cow-wheat, and the alpina, or mountain eye-bright cow-wheat, are natives of Britain.

**BARUA**, a city of Abyssinia, in Africa, the capital of the kingdom of Barnagassa.

**BARULES**, in church-history, certain heretics, who held that the Son of God had only a phantom of a body; that souls were created before the world, and that they lived all at one time.

**BARUTH**, an Indian measure, containing seventeen gantans: It ought to weigh about three pounds and an half English avoirdupois.

**BARYTONUM**, in the Italian music, the same with our bass. See **BASS**.

**BAS-RELIEF**. See **BASSO-RELIEVO**.

**BASALTES**, in natural history, called also *coticula*, *lapis heraclius*, and *lapis lydius*, a kind of marble, of a very fine texture, of a deep glossy black, resembling that of polished steel, and mixed with no other colour, nor any extraneous matter. The most remarkable quality of this marble is its figure, being never found in strata, like other marbles, but always standing up in the form of regular angular columns, composed of a number of joints, one placed on and nicely fitted to another, as if formed by the hands of a skilful workman. It is remarkably hard and heavy, will not strike fire with steel, and is a fine touch-stone. See Plate LI. fig. 20. The basaltis was originally found in columns in Ethiopia, in fragments in the river Tmolus, and some other places; we now have it frequently, both in columns and small pieces, in Spain, Russia, Poland, near Dresden, and in Silesia; but the noblest store in the world seems to be that called the *Giant's causeway*, in Ireland, where it rises far up in the country, runs into the sea, crosses its bottom, and rises again on the opposite land.

**BASANUS**, or **BASANITES**, names used by ancient writers for the basaltis.

**BASARUCO**, in commerce, a small base coin in the East Indies, being made only of very bad tin. There are, however, two sorts of this coin, a good and a bad; the bad is one sixth in value lower than the good.

**BASE**, in geometry, the lowest side of the perimeter of a figure: Thus, the base of a triangle may be said of any of its sides, but more properly of the lowest, or that which is parallel to the horizon. In rectangled triangles, the base is properly that side opposite to the right angle.

**BASE** of a *solid figure*, the lowest side, or that on which it stands.

**BASE** of a *conic section*, a right line in the hyperbola and parabola, arising from the common intersection of the secant plane, and the base of the cone.

*Altern* **BASE**. See **ALTERN**.

**BASE**, in architecture, is used for any body which bears another, but particularly for the lower part of a column and pedestal. See **ARCHITECTURE**.

**BASE**, in fortification, the exterior side of the polygon, or that imaginary line which is drawn from the flanked angle of a bastion, to the angle opposite to it.

**BASE**, in gunnery, the least sort of ordnance, the diameter of whose bore is  $1\frac{1}{4}$  inch, weight 200 pound, length 4 feet, load 5 pound, shot  $1\frac{1}{4}$  pound wt. and diameter  $1\frac{1}{4}$  inch.

**BASE** *line*, in perspective, the common section of a picture, and the geometrical plane.

*Distinct* **BASE**, in optics. See **FOCUS**.

**BASE** of the *heart*, in anatomy, denotes its upper part.

**BASE**, or **BASS**, in music. See **BASS**.

**BASE** *point*, in heraldry. See **POINT**.

**BASELLA**, in botany, a genus of the pentandria trigynia class. It has no calix; the corolla has 6 divisions; and there is but one seed in the capsule. The species are 3, *viz.* the *rubra*, *alba*, and *lucida*, all natives of India.

**BASEMENT**, in architecture, a base continued a considerable length, as round a house, room, &c. See **ARCHITECTURE**.

**BASHAW**, a Turkish governor of a province, city, or other district.

Bashaws include beglerbegs, and sometimes sangiacbegs, though a distinction is sometimes made, and the name *bashaw* is appropriated to the middle sort, or such as have two ensigns or horse-tails carried before them. Those who have the honour of three tails, are called *beglerbegs*; and those who have only one, *sangiacbegs*.

The appellation *bashaw* is given by way of courtesy to almost every person of any figure at the grand signior's court.

**BASIENTO**, a river of the kingdom of Naples, which rises near Potenza in the Basilicate, waters that province, and runs into the gulf of Tarento.

**BASIGLOSSUS**, or **BASIOGLOSSUS**. See **BASIOGLOSSUM**.

**BASIL**, in geography, a city and canton of Switzerland, near the confines of Alsace, situated on both sides the river Rhine.

The city is large, populous, and fortified; being situated in  $7^{\circ} 40'$  E. long. and  $47^{\circ} 40'$  N. lat.

**BASIL**, in botany. See **OCYUMUM**.

**BASIL**, among joiners, the sloping edge of a chissel, or of the iron of a plane, to work on soft wood: They

usually make the basil 12 degrees, and for hard wood 18; it being remarked, that the more acute the basil is, the better the instrument cuts; and the more obtuse, the stronger and fitter it is for service.

*Order of St* **BASIL**, the most ancient of all the religious orders, was very famous in the east. It passed into the west about the year 1057, and was held in great esteem, especially in Italy. As to their rules, the Italian monks of that order fast every Friday in the year: They eat meat but three times a week, and then but once a-day: They work all together at certain hours of the day: Their habit is nearly like that of the Benedictines, and they wear a small beard like the fathers of the mission.

**BASILARE** *os*, in anatomy, the same with *os sphenoides*. See **SPHENOIDES**.

**BASILIC**, in ancient architecture, a term used for a large hall, or public place, with isles, porticos, galleries, tribunals, &c. where princes sat and administered justice in person.

**BASILICA**, in anatomy, the interior branch of the axillary vein, running the whole length of the arm.

**BASILICATE**, a province of the kingdom of Naples, having the Terra di Barri on the north, and the province of Calabria on the south.

**BASILICI**, a denomination given in the Greek empire to those who carried the emperor's orders and commands.

**BASILICON**, in pharmacy, an epithet for a great many compositions to be found in the ancient medicinal writers: But it more particularly denotes an officinal ointment, composed of wax, resin, pitch, and oil of olives, from thence called *tetrapharmacum*. It is much used in wounds.

**BASILICS**, a body of the Roman laws, translated into Greek. The basilics comprehend the institutes, digests, code, novels, and some edicts of Justinian and other emperors.

**BASILICUS**, in astronomy, *cor leonis*, a fixed star of the first magnitude in the constellation Leo. See **LEO**.

**BASILIDIANS**, in church-history, a branch of gnostics, who maintained that Christ's body was only a phantom, and that Simon the Cyrenean suffered in his stead.

**BASILIGOROD**, a city of the Russian empire, in Muscovitish Tartary, situated upon the banks of the Wolga.

**BASILISCUS**, in zoology, the trivial name of a species of lacerta. See **LACERTA**.

**BASILISK**, in military affairs, a large piece of ordnance, being a 48-pounder, and weighing about 7200 pounds. Those of the French were 10 feet long, and those of the Dutch 15. The French do not cast any more of that calibre.

**BASINGSTOKE**, a market-town of Hampshire, about 16 miles north-east of Winchester, in  $1^{\circ} 15'$  W. lon. and  $51^{\circ} 20'$  N. lat.

**BASIOGLOSSUS**, in anatomy, a muscle arising from the base of the *os hyoides*.

**BASIS**, *base*, in geometry. See **BASS**.

**BASIS**

**Basis**, among physicians, denotes the principal ingredients in compound medicines.

**BASKET**, a machine made of twigs interwoven together, in order to hold fruit, earth, &c. It denotes an uncertain quantity, as a basket of medlars is two bushels, of asa foetida from 20 to 50 pound weight.

**BASKETS of earth**, in the military art, called by the French *corbeilles*, are small baskets used in sieges, on the parapet of a trench, being filled with earth. They are about a foot and a half high, about a foot and a half diameter at the top, and 8 or 10 inches at bottom; so that being set together, there is a sort of embrasures left at their bottoms, through which the soldiers fire, without exposing themselves.

**BASKET-FISH**. See **ASTERIAS**.

**BASKET-SALT**, that made from salt-springs, being purer, whiter, and composed of finer grains than the common brine-salt.

**BASKET-TENURE**, a tenure of lands by the service of making the king's baskets.

**BASKIRI**, a country of Muscovitish Tartary, bounded on the north by the Tartars of Tumen, on the east by Barabinskoi, on the south by the mountain Sortora, and on the west by the dutchy of Bulgaria.

**BASON**, in anatomy. See **PELVIS**.

**BASON**, in hydraulics, a reservoir of water, used for various purposes: Thus we say, *The bason of a jet d'eau*, *the bason of a fountain*, and likewise *the bason of a port or harbour*.

**BASON**, in Jewish antiquities, the laver of the tabernacle, made of the brass looking-glasses belonging; to those devout women that watched and stood centinels at the door of the tabernacle.

**BASON**, in mechanics, a term used by glass-grinders for a dish of copper, iron, &c. in which they grind convex glasses, as concave ones are formed on spheres: And by hatters for a round iron mould, in which they form the matter of their hats; and also for a leaden one for the brims of hats, having an aperture in the middle, of a diameter sufficient for the largest block to go through.

**BASONS of a balance**, the two scales or dishes fastened to the extremities of the strings, the one to hold the weight, and the other the thing to be weighed.

**Sale by the BASON**, at Amsterdam, is a public sale made by authority, over which presides an officer, appointed by the magistrates. It is so called, because, before the lots are delivered to the highest bidder, they commonly strike on a copper bason, to give notice that the lot is going to be adjudged.

**BASQUE**, or **LABOUR**, the south-west division of the province of Gascony, in France.

**BASS**, in music, that part of a concert which is most heard, which consists of the gravest and deepest sounds, and which is played on the largest pipes or strings of a common instrument, as of an organ, lute, &c. or on instruments larger than ordinary, for that purpose, as bass-voices, bassoons, bass-hautboys, &c. The bass is the principal part of a musical composition, and the foundation of harmony; for which reason it is a ma-

xim among musicians, That when the bass is good, the harmony is seldom bad.

**Thorough-Bass** is the harmony made by the bass-voice, or theorbo, continuing to play both while the voices sing, and the other instruments perform their parts, and also filling up the intervals when any of the other parts stop. It is played by cyphers marked over the notes, on the organ, spinet, harpsicord, &c. and frequently simply and without cyphers on the bass-viol and bassoon.

**Counter-Bass** is a second or double bass, where there are several in the same concert.

**Bass**, in geography, a steep rock, with an old fort, accessible only at one place, lying on the coast of E. Lothain in Scotland, at the mouth of the frith of Forth.

**BASSAIM**, or **BACCEIM**, a port-town of the Hither India, subject to the Portuguese, situated in 71° 5' E. long. and 19° 30' N. lat.

**BASSANUS**, in ornithology. See **PELICANUS**.

**BASSE**, a town of French Flanders, upon the confines of Artois, situated in 3° 30' E. lon and 50° 53' N. lat.

**BASSEMPAIN**, a town of Gascony, in France.

**BASSET**, a game at cards, said to have been invented by a noble Venetian, for which he was banished.

The persons concerned in it are a dealer, or banker; his assistant, who supervises the losing cards; and the purser, or any one who plays against the banker.

**BASSIGNY**, the south-east division of the province of Champaign, in France. See **CAMPAIGN**.

**BASSOON**, a musical instrument of the wind-sort, blown with a reed, furnished with eleven holes, and used as a bass in a concert of hautboys, flutes, &c.

To render this instrument more portable, it is divided into two parts, whence it is also called a fagot. Its diameter at bottom is nine inches, and its holes are stopped like those of a large flute.

**BASSORA**, a large city of Asia, situated below the conflux of the Tigris and Euphrates, in 53° E. long. and 30° 20' N. lat.

**BASSO-RELIEVO**, or **BASS-RELIEF**, a piece of sculpture, where the figures or images do not protuberate, jet, or stand out far above the plane on which they are formed.

Whatever figures or representations are thus cut, stamped, or otherwise wrought, so that not the entire body, but only part of it is raised above the plane, are said to be done in relief, or relievō; and when that work is low, flat, and but a little raised, it is called low relief: When a piece of sculpture, a coin, or a medal, has its figure raised so as to be well distinguished, it is called bold, and we say its relief is strong.

**BASS-VIOL**, a musical instrument of the like form with that of a violin, but much larger. It is struck with a bow as that is, has the same number of strings, and has eight stops, which are subdivided into semi-stops: Its sound is grave, and has a much nobler effect in a concert than that of the violin.

**BASTERNA**, a sort of vehicle, much the same with our chariot, used by the ancient Roman ladies. This was a different carriage from the lectica, which it succeeded,

- ceeded, inasmuch as the lectica was borne on mens shoulders, whereas this was drawn by beasts.
- BASTIA**, the chief city of the island of Corfica. It is a good port, situated on the north-east part of the island, in  $9^{\circ} 40'$  E long. and  $42^{\circ} 20'$  N. lat.
- BASTILE**, a castle for state prisoners in Paris, answering to the Tower of London.
- BASTIMENTOS**, small islands on the coast of Darien, in South America, lying a little to the eastward of Porto Bello.
- BASTION**, in the modern fortification, a huge mass of earth, faced usually with sods, sometimes with brick, and rarely with stone, standing out from a rampart, whereof it is a principal part, and is what, in the ancient fortification, was called a bulwark. See FORTIFICATION.
- Solid BASTIONS* are those that have the void space within them filled up entirely, and raised of an equal height with the rampart.
- Void and hollow BASTIONS* are those that are only surrounded with a rampart and parapet, having the space within void and empty, where the ground is so low, that if the rampart be taken, no retrenchment can be made in the centre, but what will lie under the fire of the besieged.
- Flat BASTION*, is a bastion built in the middle of the curtain, when it is too long to be defended by the bastion at its extremes.
- Cut BASTION* is that whose point is cut off, and instead thereof has a re-entering angle, or an angle inwards with two points outwards, and is used either when without such a contrivance the angle would be too acute, or when water or some other impediment hinders the carrying on the bastion to its full extent.
- Composed BASTION* is when two sides of the interior polygon are very unequal, which makes the gorges also unequal.
- Deformed BASTION* is when the irregularity of the lines and angles makes the bastion out of shape, as when it wants one of its demigorges, one side of the interior polygon being too short.
- Demi BASTION* is composed of one face only, and but one flank, and a demigorge.
- Double BASTION* is that which is raised on the plane of another bastion.
- Regular BASTION* is that which has its true proportion of faces, flanks, and gorges.
- BASTION DE FRANCE**, a fortress in the kingdom of Tunis, subject to France. It is situated about 80 miles west of the city of Tunis, in  $8^{\circ}$  E. long. and  $36^{\circ} 30'$  N. lat.
- BASSTOIGNE**, a town of the Netherlands, in the province of Luxemburg, situated in  $5^{\circ} 26'$  E. long. and  $50^{\circ}$  N. lat.
- BASTON**, in law, one of the servants to the warden of the Fleet prison, who attends the king's courts with a red staff, for taking into custody such as are committed by the court. He also attends on such prisoners as are permitted to go at large by licence.
- BASTON**, or **BATOON**, in architecture, a moulding in the base of a column, called also a tore.
- BASTON**, or **BATOON**, in heraldry, a kind of bend, having only one third of the usual breadth.
- The baston does not go from side to side, as the bend or scarf does, being in the form of a truncheon. Its use is a note or mark of bastardy. See Plate LI. fig. 9.
- BASTONADE**, or **BASTINADO**, a kind of punishment inflicted by beating the offender with a stick. This sort of beating, among the ancient Greeks and Romans, was the punishment commonly inflicted on criminals that were freemen, as that of whipping was on the slaves. We find some instances of this sort of discipline among the Hebrews; and it is a penalty used in the east even at this day.
- BAT**, in zoology. See **VESPERTILIO**.
- BAT**, **BATE**, or **BATZ**, a small copper coin, mixed with a little silver, current in several cities of Germany: it is worth four crutzers. It is also a coin in Switzerland, current at five livres, or one hundred sols, French money.
- BATABLE ground**, that land which lay between Scotland and England, when the kingdoms were distinct, to which both nations pretended a right.
- BATACALO**, a fort and town on the eastern coast of the island of Ceylon, in  $81^{\circ}$  E. long. and  $8^{\circ}$  N. lat.
- BATAVIA**, the capital of all the Dutch colonies and settlements in the East Indies. It is situated on the east part of the island of Java, and has an excellent harbour, in  $106^{\circ}$  E. long. and  $6^{\circ}$  S. lat.
- BATCHELOR**, or **BACHELOR**, a man who still continues in the state of celibacy, or who was never married.
- BATCHELOR** was anciently a denomination given to those who had attained to knighthood, but had not a number of vassals sufficient to have their banner carried before them in the field of battle; or, if they were not of the order of bannerets, were not of age to display their own banner, but obliged to march to battle under another's banner. It was also a title given to young cavaliers, who having made their first campaign, received the military girdle accordingly. And it served to denominate him who had overcome another in a tournament, the first time he ever engaged.
- Knights BATCHELORS* were so called, as being the lowest order of knights, or inferior to bannerets.
- BATCHELORS**, in an university-sense, are persons that have attained to the baccalaureate, or who have taken the first degree in the liberal arts and sciences. Before a person can be admitted to this degree at Oxford, it is necessary that he study there four years; three years more may intitle him to the degree of master of arts; and in seven years more he may commence batchelor of divinity. At Cambridge the degrees are usually taken much the same as at Oxford, excepting in law and physic, in either of which the batchelor's degree may be taken in six years. In France, the degree of batchelor of divinity is attained in five year's study; that is, in two years of philosophy, and three of divinity.
- BAT-FOWLING**, a method of catching birds in the night, by lighting some straw, or torches, near the place

place where they are at roost; for upon beating them up, they fly to the flame, where being amazed, they are easily caught in nets, or beat down with bushes fixed to the end of poles, &c.

**BATENBOURG**, a town of the United Provinces, situated upon the Maese, between Ravenstein and Megen.

**BATH**, a sufficient quantity of water collected in some convenient receptacle, for people to wash in, either for health or pleasure.

Baths are distinguished into natural and artificial, and natural again into hot and cold. The chief hot baths in our country are those at Bath, near Wells, in Somersetshire; and those at Buxton and Matlock in Derbyshire.

In the city of Bath are four hot baths: one triangular, called the cross bath, the heat of which is more gentle than that of the rest, because it has fewer springs in it; the second is the hot bath, which was formerly much hotter than the rest, but it was then not so large as at present: the other two are the King's and Queen's Bath, divided only by a wall; the last having no spring, but receives its water from the King's Bath: each of these is furnished with a pump, to throw out the water upon the diseased, where that is required.

These waters abound with a mineral sulphur; they are hot, of a bluish colour, and strong scent; they do not pass through the body like most other mineral waters; though if salt be added, they purge presently. On settlements, they afford a black mud, which is used by way of cataplasm in aches, and proves of more service to some than the waters themselves: The like they deposit on distillation, and no other: The cross-bath preys on silver, all of them on iron, but none on brass.

The use of these baths is found beneficial in disorders of the head, as palsies, &c. in cuticular diseases, as leprosy, &c. obstructions, and constipations of the bowels, the scurvy and stone, and in most diseases of women and children; they are used as a last remedy in obstinate chronic diseases, where they succeed well, if they agree with the constitution of the patient.

Of the three hot European waters of note, viz. Aix-la-Chapelle, Bourbon, and Bath, the first abounds more eminently in sulphur, which makes its heat, nau- seousness, and purgative faculty so great, that few stomachs can bear it.

The Bourbon are of a middle nature, between the Aix-la-Chapelle and the Bath waters; being less hot, nau- seous, and purgative than those of Aix-la-Chapelle; but more so than the Bath waters.

Cold baths were by the ancients held in the greatest esteem; and though they were long banished out of medicine, the present age can boast of abundance of noble cures performed by them, and such as were long attempted in vain by the most powerful medicines.

The cold bath is serviceable in most chronic disorders; it always acts the part of a diuretic; and will do more, especially plunging over head in sea-water, in the cure of melancholy, madness, and particularly that occasioned by the bite of a mad dog, than any other medicine.

Artificial baths are various, according to the various occasions; as aqueous baths, vaporous baths, dry baths, &c. Aqueous baths are made from common plants, and other emollient, resolvent, and nerve substances; consisting sometimes of milk and emollient herbs, with rose-water, &c. when the design is to humectate, or when it is only to cleanse, it consists of bran and water alone; and when it is for an excessive pain or tumour, &c. in these cases it consists of a decoction of roots, plants, and some spirit of wine.

In vapour-baths, the design of which is to promote a perspiration, the steam or fume of some decoction is received upon some part of the body for that purpose. In these baths there is no part of the patient's body plunged into the decoction, only those parts which require it are properly disposed to receive the steams of some proper fomentation. Of this kind are the bagnios, where persons are made to sweat by the heat of a room, and pouring on of hot water.

Vapour-baths are of singular service in cold distempers, anasarca's, œdematous tumours, paralytic cases, swellings of the testicles, &c.

Dry baths are made of ashes, salt, sand, shreds of leather, &c. This bath is successful in provoking sweat in a plentiful manner, the patient being placed conveniently for the reception of the fumes: They are found useful in removing old obstinate pains, and are very effectual in venereal complaints.

**BATH**, in Hebrew antiquity, a measure of capacity, containing the tenth part of an omer, or seven gallons and four pints, as a measure for things liquid; or three pecks and three pints, as a measure for things dry.

**BATHS**, in architecture, superb buildings, erected for the sake of bathing.

Those buildings, among the ancients, were most pompous and magnificent; such were those of Titus, Paulus Æmilius, and Dioclesian, whose ruins are still remaining.

**BATH**, in geography, a city of Somersetshire, situated on the river Avon, ten miles east of Bristol, in 2° 30' W. long. and 51° 30' N. lat.

**BATH** is also the name of a town in Hungary, in 20° 40' E. long. and 46° N. lat.

*Knights of the BATH*, a military order in England, supposed to have been instituted by Richard II. who limited their number to four: However, his successor, Henry IV. increased them to forty-six. Their motto was *tres in uno*, signifying the three theological virtues.

This order received this denomination from a custom of bathing, before they received the golden spur. It is seldom ever conferred but at the coronation of kings, or the inauguration of a prince of Wales or Duke of York. They wear a red ribbon beltwise.

The order of the bath, after remaining many years extinct, was revived under George I. by a solemn creation of a great number of knights.

**BATH-kol**, the daughter of a voice. So the Jews call one of their oracles, which is frequently mentioned in their books, especially the Talmud, being a fantastical way of divination invented by the Jews themselves, not unlike the *sortes virgiliane* of the heathens. How-

ever, the Jewish writers call this a revelation from God's will, which he made to his chosen people, after all verbal prophecies had ceased in Israel.

**BATH-metal**, a mixed metal, otherwise called *prince's metal*. See **PRINCE'S METAL**.

**BATH-water**. See the article **BATH**.

**BATHA**, the name of two towns, the one in Barbary, in the kingdom of Algiers, and the other in Hungary, upon the banks of the Danube.

**BATHING**, the washing, soaking, suppling, refreshing, moistening, &c. the body, or any part thereof, in water, liquor, &c. for pleasure or health. See **BATH**.

**BATHING a falcon**, is when, weaned from her ramage fooleries, she is offered some water to bathe herself in a basin, where she may stand up to her thighs. By this means she gathers strength and boldness.

**BATHMUS**, in anatomy, denotes the cavity of a bone, fitted to receive the prominence of another bone.

**BATICALA**, in geography, a kingdom of India, upon the coast of Malabar, to the north of the kingdom of Canara.

**BATIS**, in zoology, the trivial name of a species of *raja*. See **RAJA**.

**BATMAN**, in commerce, a kind of weight use at Smyrna, containing six oke of four hundred drams each, which amount to sixteen pounds, six ounces, and fifteen drams of English weight.

**BATON**, or **BASTON**. See **BASTON**.

**BATRACHITES**, or **FROG-STONE**, a kind of gem mentioned by the ancients, and so called from its resembling the colour of a frog.

**BATRACHOMYOMACHIA**, the battle of the frogs and the mice, the title of a fine burlesque poem, usually ascribed to Homer.

The subject of the work is the death of *Psycharpax*, a mouse, son to *Toxartes*, who, being mounted on the back of *Physignathus*, a frog, on a voyage to her palace, to which she had invited him, was seized with fear, when he saw himself in the middle of the pond, so that he tumbled off and was drowned. *Physignathus* being suspected to have shaken him off with design, the mice demanded satisfaction, and unanimously declared war against the frogs.

**BATTA**, a province of the kingdom of Congo in Africa, which is watered by the river *Barbela*.

**BATTALIA**, denotes an army drawn up in order of battle.

**BATTALION**, a small body of infantry, ranged in form of battle, and ready to engage.

A battalion usually contains from 5 to 800 men; but the number it consists of is not determined. They are armed with firelocks, swords, and bayonets; and divided into thirteen companies, one of which is grenadiers. They are usually drawn up with six men in file, or one before another. Some regiments consist but of one battalion, others are divided into four or five.

**BATTEL**, a town of Sussex, six miles north of Hastings, in 35° E. long. and 50° 55' N. lat.

**BATTEN**, a name that workmen give to a scantling of

wooden stuff, from two to four inches broad, and about one inch thick; the length is pretty considerable, but undetermined.

This term is chiefly used in speaking of doors and windows of shops, &c. which are not framed of whole deal, &c. with styles, rails, and pannels like wainscot, but are made to appear as if they were, by means of these battens, bradded on the plain board round the edges, and sometimes cross them, and up and down.

**BATTENBURY**, a town of Dutch Guelderland, situated on the north shore of the river *Maese*, almost opposite to *Ravenstein*, in 5° 30' E. long. and 51° 45' N. lat.

**BATTERING**, the attacking a place, work, or the like, with heavy artillery.

To batter in breach, is to play furiously on a work, as the angle of a half-moon, in order to demolish and make a gape therein. In this they observe never to fire a piece at the top, but all at the bottom, from three to six feet from the ground.

The battery of a camp is usually surrounded with a trench, and pallisadoes at the bottom, with two redoubts on the wings, or certain places of arms, capable of covering the troops which are appointed for their defence. See **BATTERY**.

**BATTERING-pieces**, or pieces of battery. See **CANNON** and **GUNNERY**.

**BATTERING-ram**, in antiquity. See **RAM**.

**BATTERING-rams**, in heraldry, a bearing, or coat of arms, resembling the military ensign of the same name. See **Plate LI. fig. 10.**

**BATTERY**, in the military art, a parapet thrown up to cover the gunners, and men employed about the guns, from the enemy's shot. This parapet is cut into embrasures, for the cannon to fire through. The height of the embrasures, on the inside, is about three feet; but they go sloping lower to the outside. Their wideness is two or three feet, but open to six or seven on the outside. The mass of earth that is betwixt two embrasures, is called the *merlon*. The platform of a battery is a floor of planks and sleepers, to keep the wheels of the guns from sinking into the earth; and is always made sloping towards the embrasures, both to hinder the reverse, and to facilitate the bringing back of the gun.

**BATTERY of mortars** differs from a battery of guns, for it is sunk into the ground, and has no embrasures.

**Cross-BATTERIES** are two batteries, which play athwart one another, upon the same thing, forming there an angle, and beating with more violence and destruction; because what one bullet shakes, the other beats down.

**BATTERY sunk or buried**, is when its platform is sunk, or let down into the ground, so that there must be trenches cut in the earth, against the muzzles of the guns, for them to fire out at, and to serve for embrasures.

**BATTERY d'enslade**, is one that scours, or sweeps the whole length of a straight line.

**BATTERY en echarpe** is that which plays obliquely.

**BAT-**



**BATTERY** *de reverse*, that which plays upon the enemy's back.

**Camerade BATTERY** is when several guns play at the same time upon one place.

**BATTERY**, in law, the striking, beating, or offering any violence to another person, for which damages may be recovered.

**BATTEURS d'estrade**, or **SCOUTS**, are horsemen sent out before, and on the wings of an army, one, two, or three miles, to make discoveries.

**BATTLE**, a general engagement between two armies, in a country sufficiently open for them to encounter in front, and at the same time.

Other great actions, though of a longer duration, and even attended with a greater slaughter, are only called fights.

**Naval BATTLE**, the same with a sea-fight, or engagement between two fleets of men of war.

Before a naval battle, every squadron usually subdivides itself into three equal divisions, with a reserve of certain ships out of every squadron to bring up their rear. Every one of these, observing a due birth and distance, are in the battle to second one another; and the better to avoid confusion and falling foul of each other, to charge, discharge, and fall off, by threes or fives, more or less, as the fleet is greater or smaller. The ships of reserve are instructed either to succour and relieve those that are any way in danger; or to supply, and put themselves in the place of those that shall be made unserviceable.

As for a fleet consisting but of few ships, when obliged to fight in an open sea, it should be brought up to battle in only one front, with the chief admiral in the middle of them, and on each side of him the strongest and best provided ships of the fleet.

**BATTLE** is also used figuratively, for a representation of a battle in sculpture, painting, and the like.

**BATTLE-royal**, in cock-fighting, a fight between three, five, or seven cocks all engaged together, so that the cock which stands longest gets the day.

**BATTLE-ax**, a kind of halbard, first introduced into England by the Danes.

**BATTLEMENTS**, in architecture, are indentures or notches in the top of a wall or other building, in the form of embrasures, for the sake of looking through them.

**BATTUTOLOGY**, in grammar, a superfluous repetition of some words or things.

**BATTON**, **BATOON**, or **BASTON**. See **BASTON**.

**BATTERY**, in commerce, a name given by the Hanse towns to their country-houses and warehouses in foreign countries. The principal battories were at London, Archangel, Novogorod, Lisbon, Venice, and Antwerp.

**BATTUS**, an order of penitents at Avignon, and in Provence, whose piety carries them to exercise very severe discipline upon themselves, both in public and private.

**BATUECOS**, or **LOS BATUECOS**, a people of Spain in the kingdom of Leon, that inhabit the mountains be-

tween Salamanca and Corica, and are thought to be descended from the Goths.

**BATZ**, a copper coin mixed with some silver, and current at different rates, according to the alloy, in Nuremberg, Basil, Fribourg, Lucerne, and other cities of Germany and Switzerland.

**BAVARIA**, one of the circles of the German empire, lying between Austria on the east, and Swabia on the west.

The duke of Bavaria is one of the nine electors. See **ELECTOR**.

**BAVAY**, a small town in the province of Hainalt in French Flanders, about twelve miles south-west of Mons, in  $3^{\circ} 40'$  E. long. and  $50^{\circ} 25'$  N. lat.

**BAUHINIA**, in botany, a genus of the decandria monogynia class. The calix has five divisions, and is deciduous; the petals are open, oblong, and inserted by claws into the calix. The species are eight, all natives of the Indies.

**BAVINS**, in the military art, denote brush-faggots, with the brush at length.

**BAUM**, in botany. See **MELISSA**.

**BAURAC**, a name anciently used for nitre.

**BAUTZEN**, the chief town of Lusatia in Germany, about thirty-five miles north-east of Dresden, in  $14^{\circ} 30'$  E. long. and  $51^{\circ} 15'$  N. lat.

**BAWLING**, among sportsmen, the same with babbling. See **BABBING**.

**BAY**, in geography, an arm of the sea shooting up into the land, and terminating in a nook. It is a kind of lesser gulf, bigger than a creek, and is larger in its middle within than at its entrance. The largest and most noted bays in the world are those of Biscay, Bengal, Hudson's, Panama, &c.

**BAY**, among farmers, a term used to signify the magnitude of a barn; as, if a barn consists of a floor and two heads, where they lay corn, they call it a *barn of two bays*. The bays are from fourteen to twenty feet long.

**BAY** denotes likewise a pound head, made to keep in store of water for driving the wheels of the furnace or hammer belonging to an iron-mill, by the stream that comes thence through a flood-gate, called the *pen-stock*.

**BAY** is also one of the colours of the hair of horses, inclining to red, and coming pretty near the colour of a chefnut. There are five different gradations of the bay-colour, viz. chefnut-bay, light-bay, yellow-bay or dun-day, bloody-bay, which is also called scarlet-bay, and the brown-bay.

**BAY**, among huntsmen. Deer are said to stand at bay, when, after being hard run, they turn head against the hounds.

**BAY-trees**. See **LAURUS**.

**BAY-falt**. See **SALT**.

**BAYEUX**, a city of Normandy in France, about fifteen miles north-west of Caen, in  $50'$  W. long. and  $49^{\circ} 20'$  N. lat.

**BAYONET**, in the military art, a short broad dagger, formerly with a round handle fitted for the bore of a firelock, to be fixed there after the soldier had fired; but they are now made with iron handles and rings, that.

- that go over the muzzle of the firelock, and are screwed fast, so that the soldier fires with his bayonet on the muzzle of his piece, and is ready to act against the horse.
- BAYONNE**, a large city of Gascony in France, situated on the river Adour, near the bay of Biscay, in  $1^{\circ} 20'$  W. long. and  $43^{\circ} 30'$  N. lat.
- BAYS**, in commerce, a sort of open woollen stuff, having a long nap, sometimes frized, and sometimes not. This stuff is without wale, and is wrought in a loom with two treddles, like flannel. It is chiefly manufactured at Colchester and Bockin in Essex, where there is a hall called the *Dutch bay-ball* or *raw-ball*. The exportation of bays was formerly much more considerable than at present that the French have learned to imitate them. However, the English bays are still sent in great quantities to Spain and Portugal, and even to Italy. Their chief use is for dressing the monks and nuns, and for linings, especially in the army. The looking-glass makers also use them behind their glasses, to preserve the tin or quicksilver; and the case-makers, to line their cases. The breadth of bays is commonly a yard and a half, a yard and three quarters, or two yards, by 42 to 48 in length. Those of a yard and three quarters are most proper for the Spanish trade.
- BAZAR**, **BAZARI**, or **BAZAARD**, a place designed for trade among the eastern nations, particularly the Persians, some of which are open at top, like the market-places of Europe; others are covered with high-vaulted ceilings, and adorned with domes to give light. In the first, they sell only the less precious and most bulky commodities; whereas, in the latter, are the shops of those merchants who sell jewels, rich stuffs, wrought plate, &c.
- BAZAS**, a town of Guienne in France, about thirty miles south of Bourdeaux, in  $25'$  W. long. and  $44^{\circ} 20'$  N. lat.
- BAZAT**, or **BAZA**, in commerce, a long, fine, spun cotton, which comes from Jerusalem, whence it is also called *Jerusalem-cotton*.
- BDELLIUM**, is a gummy resinous concreted juice, brought from Arabia and the E. Indies, in globes of different figures and magnitudes. It is of a dark reddish brown colour, and, in appearance, somewhat resembles myrrh; and is recommended as a sudorific, diuretic, and uterine; and in external applications, for maturing tumours, &c. In the present practice, it is scarce otherwise made use of, than as an ingredient in theriaca.
- BEACHY-HEAD**, a cape or promontory on the coast of Sussex, between Hastings and Shoreham.
- BEACON**, any public signal, to give warning against rocks, shelves, invasions, &c.
- BEACONAGE**, a tax or farm paid for the use and maintenance of a beacon. Trinity-house is empowered to levy this tax by act of parliament.
- BEACONFIELD**, a market-town of Buckinghamshire, twenty-two miles west of London, in  $30'$  W. long. and  $51^{\circ} 30'$  N. lat.
- BEAD**, a small glass ball, made in imitation of pearl, and used in necklaces, &c.
- BEAD**, in architecture, a round moulding, commonly made upon the edge of a piece of stuff, in the Corinthian and Roman orders, cut or carved in short embossments, like beads in necklaces.
- BEAD-proof**, among distillers, a fallacious way of determining the strength of spirits, from the continuance of the bubbles, or beads, raised by shaking a small quantity of them in a phial.
- BEAD-roll**, among papists, a list of such persons, for the rest of whose souls they are obliged to repeat a certain number of prayers, which they count by means of their beads.
- BEADLE**, a messenger or apparitor of a court, who cites persons to appear and answer in the court to what is alleged against them.
- BEADLE** is also an officer at an university, whose chief business it is to walk before the masters with a mace, at all public processions.
- BEAGLE**, the name of a particular kind of hunting-dogs, of which there are several sorts, viz. the southern beagle, which is something less than the deep-mouthed hound, and something thicker and shorter; the fleet-northern, or cat-beagle, which is smaller and of a finer shape than the southern beagle, and is a hard runner: There is also a very small beagle, not bigger than a lady's lap-dog.
- BEAK**, the bill or nib of a bird.
- BEAK**, in architecture, the small fillet left on the head of a larmier, which forms a canal, and makes a kind of pendant.
- Chin* **BEAK**, a moulding the same as the quarter-round, except that its situation is inverted: This is very frequent in modern buildings, though few examples of it are found in the ancient.
- BEAK**, or **BEAK-head**, of a ship, that part without the ship, before the fore-castle, which is fastened to the stem, and is supported by the main keel.
- BEAKED**, in heraldry, a term used to express the beak or bill of a bird. When the beak and legs of a fowl are of a different tincture from the body, we say beaked and membered of such a tincture.
- BEAKING**, among cock-fighters, is when one cock holds another by his bill, and strikes him with his spurs or gafflers at the same time.
- BEAM**, in architecture, the largest piece of wood in a building, which lies cross the walls, and serves to support the principal rafters of the roof, and into which the feet of these rafters are framed.
- BEAMS of a ship** are the great main cross-timbers which hold the sides of the ship from falling together, and which also support the decks and orlops: The main beam is next the main-mast, and from it they are reckoned by first, second, third beam, &c. the greatest beam of all is called the *mid-ship beam*. See **SHIP**.
- BEAM-compass**, an instrument consisting of a square wooden or brass beam, having sliding sockets, that carry steel or pencil points; they are used for describing large circles, where the common compasses are useless.

BEAM,

**BEAM**, in heraldry, the term used to express the main horn of a hart or buck.

**BEAM**, among hunters, the main stem of a deer's head, or that part which bears the antlers, royals, and tops.

**Chamber-BEAM.** See **CHAMBER-beam**.

**BEAM** is also the name of a sort of fiery meteor in the shape of a pillar; also a ray of the sun.

**BEAM-filling**, in building, the filling up of the vacant space between the rafter and roof, with stones or bricks laid between the rafters on the rafter, and plastered on with loam, where the garrets are not pargeted, or plastered, as in country places, where they do not parget or plaster their garrets.

**BEAM of an anchor**, the longest part of it, called also the *shank*.

**BEAM-feathers**, in falconry, the longest feathers of a hawk's wing.

**BEAM** also denotes the lath, or iron, of a pair of scales; sometimes the whole apparatus for weighing of goods is so called: Thus we say, it weighs so much at the king's beam.

**BEAM of a plough**, that in which all the parts of the plough-tail are fixed. See **AGRICULTURE**.

**BEAM**, or **ROLLER**, among weavers, a long and thick wooden cylinder, placed length-ways on the back-part of the loom of those who work with a shuttle.

That cylinder, on which the stuff is rolled as it is weaved, is also called the beam or roller, and is placed on the fore-part of the loom.

**BEAN**, in botany. See **VICIA**.

**BEAR**, in zoology. See **URSUS**.

**BEAR**, in astronomy. See **URSA**.

**BEAR**, in heraldry. He that has a coat of arms is said to bear in it the several charges or ordinaries that are in his escutcheon.

**BEAR**, in gunnery. A piece of ordnance is said to come to bear, when it lies right with, or directly against the mark.

**BEARALSTON**, a borough of Devonshire, situated on the river Tamar, about ten miles north of Plymouth, in 4° 30' W. long. and 50° 35' N. lat. It sends two members to parliament.

**BEAR'S-breech.** See **ACANTHUS**.

**BEARD**, the hair growing on the chin, and adjacent parts of the face, chiefly of adults and males. See **ANATOMY**. p. 256.

Various have been the ceremonies and customs of most nations in regard of the beard. The Tartars, out of a religious principle, waged a long and bloody war with the Persians, declaring them infidels merely because they would not cut their whiskers after the rite of Tartary: And we find, that a considerable branch of the religion of the ancients consisted in the management of their beard. Ecclesiastics have sometimes been enjoined to wear, and at other times have been forbid the wearing, the beard; and the Greek and Romish churches have been a long time by the ears, about their beards. To let the beard grow, in some countries, is a token of mourning, as to shave it is the like in others.

The Greeks wore their beards till the time of Alex-

ander the Great, that prince having ordered the Macedonians to be shaved, for fear it should give a handle to their enemies. The Romans did not begin to shave till the year of Rome 454. Nor did the Russians cut their beards till within these few years, that Peter the Great, notwithstanding his injunction upon them to shave, was obliged to keep on foot a number of officers to cut off, by violence, the beards of such as would not otherwise part with them.

**BEARD of a comet**, the rays which the comet emits towards that part of the heaven to which its proper motion seems to direct it, in which the beard of a comet is distinguished from the tail, which is understood of the rays emitted towards that part from whence its motion seems to carry it.

**BEARD of a horse**, that part underneath the lower mandible on the outside and above the chin, which bears the curb. It is also called the chuck.

It should have but little flesh upon it, without any chops, hardness, or swelling, and neither too high raised nor too flat, but such as the curb may rest in its right place.

**BEARDED bush**, among florists, is a bush, hairy on the edges.

**BEARDING of wool.** See **WOOL**.

**BEARER**, in architecture, a post, or brick-wall, trimmed up between the two ends of a piece of timber, to shorten its bearing, or to prevent its bearing with the whole weight at the ends only.

**BEARER of a bill of exchange**, the person in whose hands the bill is, and in favour of whom the last order was made.

When a bill is made payable to the bearer, it is understood to be payable to him in whose hands it is, after it becomes due. See **BILL**.

**BEARERS**, in heraldry. See **SUPPORTERS**.

**Cross-BEARERS.** See **CROSS**.

**BEARING**, in navigation and geography, the situation of one place from another, with regard to the points of the compass; or the angle which a line drawn through the two places, makes with the meridians of each.

**BEARING**, in the sea language. When a ship sails towards the shore, before the wind, she is said bear in with the land or harbour. To let the ship sail more before the wind, is to bear up. To put her right before the wind, is to bear round. A ship that keeps off from the land, is said to bear off. When a ship that was to windward comes under another ship's stern, and so gives her the wind, she is said to bear under her lee, &c. There is another sense of this word, in reference to the burden of a ship; for they say a ship bears, when having too slender or lean a quarter, she will sink too deep into the water with an over light freight, and thereby can carry but a small quantity of goods. See **NAVIGATION**.

**BEARING of a piece of timber**, among carpenters, the space either between the two fixed extremes thereof, when it has no other support, which they call bearing at length, or between one extreme and a post, brick-wall, &c. trimmed up between the ends to shorten its bearings.

**High BEARING cock**, one larger than the cock he fights with.

**BEARING claws**, among cock-fighters, the foremost toes of a cock. If these are hurt or gravelled, he cannot fight.

**BEARN**, a province in the south of France, bounded by Gascony on the North, and by the Pyrenean mountains, which separate it from Spain, on the south.

**BEAST** among gamesters, a game at cards, played in this manner: The best cards are the king, queen, &c. whereof they make three heaps, the king, the play, and triolet.

Three, four, or five may play; and to every one is dealt five cards. However, before the play begins, every one stakes to the three heaps. He that wins most tricks, takes up the heap called the play: He that hath the king, takes up the heap so called; and he that hath three of any sort, that is, three fours, three fives, three sixes, &c. takes up the triolet heap.

**BEAST**, in a general sense, an appellation given to all four-footed animals, fit either for food, labour, or sport.

**BEASTS of burden**, in a commercial sense, all four-footed animals which serve to carry merchandizes on their backs. The beasts generally used for this purpose, are elephants, dromedaries, camels, horses, mules, asses, and the sheep of Mexico and Peru.

**BEASTS of the chace** are five; viz. the buck, the doe, the fox, the roe, and the martin.

**BEASTS and fowls of the warren**, are the hare, the coney, the pheasant, and partridge.

**BEASTS of the forest** are the hart, hind, hare, boar, and wolf.

**Rother-BEASTS**. See **ROTHER**.

**BEAT**, in a general signification, signifies to chastise, strike, knock, or vanquish.

This word has several other significations in the manufactures, and in the arts and trades. Sometimes it signifies to forge and hammer, in which sense smiths and farriers say, to beat iron; sometimes it means to pound, to reduce into powder: Thus we say, *to beat drugs*, *to beat pepper*, *to beat spices*; that is to say, *to pulverise them*.

**BEAT of drum**, in the military art, is to give notice by beat of drum of a sudden danger; or, that scattered soldiers may repair to their arms and quarters, is to beat an alarm, or to arms; also to signify, by different manners of sounding a drum, that the soldiers are to fall on the enemy; to retreat before, in, or after an attack; to move, or march, from one place to another; to treat upon terms, or confer with the enemy; to permit the soldiers to come out of their quarters at break of day: to order to repair to their colours, &c. is to beat a charge, a retreat, a march, &c.

**BEATIFIC VISION**. See **VISION**.

**BEATIFICATION**, among papists, an act by which the pope declares a person beatified, or blessed after death.

This is the first step towards canonization, and differs from it; because in the former, the pope does not act as a judge, determining the state of the beatified, but only gives a privilege to certain persons to honour him by a particular religious worship, without incurring the penalty of superstitious worship; whereas in

canonization, the pope speaks like a judge, and determines upon the state of the canonized.

No person can be beatified till sixty years after death. All certificates or attestations of virtues and miracles are examined before the congregation of rites: The examination continues for several years, after which his holiness decrees the beatification. The corpse and relics of the future saint are thenceforth exposed to the veneration of every body; his images are crowned with rays, and a particular office is set apart for him.

**BEATING**, or **PULSATION**, in medicine, the reciprocal agitation or palpitation of the heart or pulse. See **PULSE**.

**BEATING gold and silver**. See **GOLD-BEATING**, &c.

**BEATING with hunters**, a term used of a stag, which runs first one way, and then another. He is then said *to beat up and down*.

The noise made by conies in rutting time is also called *beating or tapping*.

**BEATS**, in a watch or clock, are the strokes made by the fangs or pallets of the spindle of the ballance, or of the pads in a royal pendulum. See **WATCH-MAKING**.

**BEAUCAIRE**, a town of Languedoc, situated on the western shore of the river Rhone, about seven miles north of Arles; in 4° 40' E. long. and 43° 40' N. lat.

**BEAVER**, in zoology. See **CASTOR**.

**BEAUFORT**, a town of the duchy of Anjou in France, situated 15 miles east of Angers; in 15° E. long. and 47° 30' N. lat.

**BEAUFORT** is also a town of Savoy, about 30 miles east of Chambery; in 6° 40' E. long. and 45° 30' N. lat.

**BEAUGENCY**, a town of Orleans, in France; situated on the river Loire, about 15 miles south-west of Orleans, in 1° 36' E. long. and 47° 48' N. lat.

**BEAUJEU**, a town of the Lyonois in France, about 25 miles north-west of Lyons; in 4° 30' E. long. and 46° 15' N. lat.

**BEAUJOLOIS**, the south-east division of the Lyonois, and so called from Beaujeu.

**BEAUMARIS**, a market town of Anglesey in Wales; situated about nine miles north of Bangor, in 4° 15' W. long. and 53° 25' N. lat.

**BEAU-MASS**. See **MASS**.

**BEAUMONT**, a town of Hainalt, about 17 miles south-east of Mons; in 4° 15' E. long. and 50° 20' N. lat.

**BEAUMONT** is also a town of France, about 16 miles south of Alençon; in 5° E. long. and 48° 20' N. lat.

**BEAUNE**, a town of Burgundy in France, situated in 5° 20' E. long. and 47° 2' N. lat.

**BEAUTY**, in its native signification, is appropriated to objects of sight. Objects of the other senses may be agreeable, such as the sounds of musical instruments, the smoothness and softness of some surfaces; but the agreeableness called beauty belongs to objects of sight.

Objects of sight are more complex than those of any other sense: In the simplest, we perceive colour, figure, length, breadth, thickness. A tree is composed of a trunk, branches, and leaves; it has colour, figure, size, and sometimes motion: By means of each of these particulars, separately considered, it appears beautiful;

ful; but a complex perception of the whole greatly augments the beauty of the object. The human body is a composition of numberless beauties arising from the parts and qualities of the object, various colours, various motions, figures, size, &c. all united in one complex object, and striking the eye with combined force. Hence it is, that beauty, a quality so remarkable in visible objects, lends its name to every thing that is eminently agreeable. Thus, by a figure of speech, we say, a beautiful sound, a beautiful thought, a beautiful discovery, &c.

Considering attentively the beauty of visible objects, two kinds are discovered. The first may be termed intrinsic beauty, because it is discovered in a single object, without relation to any other; the other may be termed relative, being founded on the relation of objects. Intrinsic beauty is a perception of sense merely; for to perceive the beauty of a spreading oak, or of a flowing river, no more is required but singly an act of vision. Relative beauty is accompanied with an act of understanding and reflection; for we perceive not the relative beauty of a fine instrument or engine, until we learn its use and destination. In a word, intrinsic beauty is ultimate; and relative beauty is that of means relating to some good end or purpose. These different beauties agree in one capital circumstance, that both are equally perceived as belonging to the object; which will be readily admitted with respect to intrinsic beauty, but is not so obvious with respect to the other. The utility of the plough, for example, may make an object of admiration or of desire; but why should utility make it beautiful? A natural propensity of the human mind will explain this difficulty: By an easy transition of ideas, the beauty of the effect is transferred to the cause, and is perceived as one of the qualities of the cause: Thus a subject void of intrinsic beauty, appears beautiful by its utility; a dwelling-house void of all regularity, is however beautiful in the view of convenience; and the want of symmetry in a tree, will not prevent its appearing beautiful, if it be known to produce good fruit.

When these two beauties concur in any object, it appears delightful. Every member of the human body possesses both in a high degree.

The beauty of utility, being accurately proportioned to the degree of utility, requires no illustration: But intrinsic beauty being more complex, cannot be handled distinctly without being analysed. If a tree be beautiful by means of its colour, figure, motion, size, &c. it is in reality possessed of so many different beauties. The beauty of colour is too familiar to need explanation. The beauty of figure is more; for example, viewing any body as a whole, the beauty of its figure arises from regularity and simplicity; viewing the parts with relation to each other, uniformity, proportion, and order, contribute to its beauty. The beauties of grandeur and motion must be considered separately. See GRANDUR, and MOTION.

We shall here make a few observations on simplicity; which may be of use in examining the beauty of single objects. A multitude of objects crowding into the

mind at once, disturb the attention, and pass without making any lasting impression: In the same manner, even a single object, consisting of a multiplicity of parts, equals not, in strength of impression, a more simple object comprehended in one view. This justifies simplicity in works of art, as opposed to complicated circumstances and crowded ornaments.

It would be endless to enumerate the effects that are produced by the various combinations of the principles of beauty. A few examples will be sufficient to give the reader some idea of this subject. A circle and a square are each perfectly regular; a square, however, is less beautiful than a circle; and the reason is, that the attention is divided among the sides and angles of a square; whereas the circumference of a circle, being a single object, makes one entire impression: And thus simplicity contributes to beauty. For the same reason, a square is more beautiful than a hexagon or octagon. A square is likewise more beautiful than a parallelogram, because it is more regular and uniform. But this holds with respect to intrinsic beauty only; for in many instances, as in the doors and windows of a dwelling-house, utility turns the scales on the side of the parallelogram.

Again, a parallelogram depends, for its beauty, on the proportion of its sides: A great inequality of its sides annihilates its beauty: Approximation toward equality hath the same effect; for proportion there degenerates into imperfect uniformity, and the figure appears an unsuccessful attempt toward a square. And hence proportion contributes to beauty.

An equilateral triangle yields not to a square in regularity nor in uniformity of parts, and it is more simple. But an equilateral triangle is less beautiful than a square; which must be owing to inferiority of order in the position of its parts; the order arising from the equal inclination of the sides of such an angle, is more obscure than the parallelism of the sides of a square. And hence order contributes to beauty not less than simplicity, regularity, or proportion.

Uniformity is singular in one circumstance, that it is apt to disgust by excess. A number of things destined for the same use, as windows, chairs, &c. cannot be too uniform. But a scrupulous uniformity of parts in a large garden or field, is far from being agreeable.

In all the works of nature, simplicity makes a capital figure. It also makes a figure in works of art: Profuse ornament in painting, gardening, or architecture, as well as in dress or in language, shows a mean or corrupted taste. Simplicity in behaviour and manners has an enchanting effect, and never fails to gain our affection. Very different are the artificial manners of modern times. A gradual progress from simplicity to complex forms and profuse ornament, seems to be the fate of all the fine arts; resembling behaviour, which from original candor and simplicity, has degenerated into duplicity of heart and artificial refinements: At present literary productions are crowded with words, epithets, figures: In music, sentiment is neglected for the luxury of harmony, and for difficult movement.

With regard to the final cause of beauty, one thing is evident, that our relish of regularity, uniformity, proportion,

portion, order, and simplicity contributes greatly to enhance the beauty of the objects that surround us, and of course tends to our happiness. We may be confirmed in this thought, upon reflecting, that our taste for these particulars is not accidental, but uniform and universal, making a branch of our nature. At the same time, regularity, uniformity, order, and simplicity, contribute, each of them, to readiness of apprehension, and enable us to form more distinct ideas of objects than can be done where these particulars are wanting. In some instances, as in animals, proportion is evidently connected with utility, and is the more agreeable on that account.

Beauty, in many instances, promotes industry, and as it is frequently connected with utility, it proves an additional incitement to enrich our fields and improve our manufactures. These, however, are but slight effects, compared with the connections that are formed among individuals in society by means of beauty. The qualifications of the head and heart are undoubtedly the most solid and most permanent foundations of such connections: But, as external beauty lies more in view, and is more obvious to the bulk of mankind than the qualities now mentioned, the sense of beauty has a more extensive influence in forming these connections. At any rate, it concurs in an eminent degree with mental qualifications, in producing social intercourse, mutual good-will, and consequently mutual aid and support, which are the life of society. It must not however be overlooked, that the sense of beauty does not tend to advance the interests of society, but when in a due mean with respect to strength. Love, in particular, arising from a sense of beauty, loses, when excessive, its social character; the appetite for gratification, prevailing over affection for the beloved object, is ungovernable, and tends violently to its end, regardless of the misery that must follow. Love, in this state, is no longer a sweet agreeable passion; it becomes painful, like hunger or thirst, and produceth no happiness, but in the instant of fruition. This suggests an important lesson, that moderation in our desires and appetites, which fits us for doing our duty, contributes at the same time the most to happiness; even social passions, when moderate, are more pleasant than when they swell beyond proper bounds.

**BEAUTY**, in architecture, painting, and other arts, is the harmony and justness of the whole composition taken together.

**BEAUVIN**, a city of Burgundy, in France, about 15 miles north of Chalons, in  $4^{\circ} 50'$  E. long. and  $47^{\circ}$  N. lat.

**BEAUVOIR**, a port-town of France, about 25 miles south-west of Nants, in  $2^{\circ}$  W. long. and  $47^{\circ}$  N. lat.

**BEAUVOIS**, a city of the isle of France, about 43 miles north of Paris, in  $2^{\circ} 20'$  E. long. and  $4^{\circ} 30'$  N. lat.

**BECAH**, or **BEKAH**, in Hebrew antiquity, a Jewish coin, equal to  $13\frac{1}{2}$  *d.* of our money.

**BECALM**, in a general sense, signifies to appease, to allay.

**BECALM**, in the sea language. A ship is said to be be-

calmed, when there is not a breath of wind to fill the sails.

**BECANER**, the capital of the territory of Becar in India, situated on the river Ganges, in  $83^{\circ}$  E. long. and  $28^{\circ}$  N. lat.

**BECCABUNGA**, in botany, the trivial name of a species of veronica. See **VERONICA**.

**BECHICS**, medicines designed to relieve coughs, being the same with what we call *expectorants* and *pectorals*.

**BECHIN**, a town of Bohemia, in  $15^{\circ}$  E. long. and  $49^{\circ} 14'$  N. lat.

**BECKENRIEDT**, a town of Switzerland in the canton of Underwaldt.

**BECZAU**, a town of Bohemia, upon the river Topel.

**BED**, a machine for stretching and composing the body on, for ease, or sleep, consisting generally of feathers inclosed in a ticken case. There are varieties of beds, as a standing-bed, a settee-bed, a tent-bed, a truckle-bed, &c.

**BED of justice**, in the French customs, a throne upon which the king is seated when he goes to the parliament. The king never holds a bed of justice unless for affairs that concern the state, and then all the officers of parliament are clothed in scarlet robes.

**BED of the carriage of a great gun**, a thick plank, that lies under the piece; being, as it were, the body of the carriage.

**BED**, in masonry, a course, or range of stones; and the joint of the bed is the mortar between two stones, placed over each other.

**BED**, in gardening, square or oblong pieces of ground, in a garden, raised a little above the level of the adjoining ground, and wherein they sow seeds, or plant roots.

**Hot-BED**. See **HOT-BED**.

**Lords of the BED-CHAMBER**, in the British customs, ten lords who attend in their turns, each a week; during which time they lie in the king's bed-chamber, and wait on him when he dines in private.

**BEDAL**, a market-town of Yorkshire, eight miles south of Richmond, in  $1^{\circ} 20'$  W. long. and  $54^{\circ} 20'$  N. lat.

**BEDEL**. See **BEADLE**.

**BEDEREPE**, a customary service, by which tenants were anciently bound to reap their landlord's corn in harvest-time.

**BEDFORD**, the county-town of Bedfordshire, situated on the river Ouse, about 22 miles south-west of Cambridge, in  $20'$  W. long. and  $52^{\circ} 10'$  N. lat.

**BED-MOULDING**, in architecture, a term used for those members of a cornice, which are placed below the coronet; and now usually consists of an ogee, a list, a large bouldine, and another list under the coronet.

**BEDOUINS**, in the Arabian customs, tribes of Arabs, who live in tents, and are dispersed all over Arabia, Egypt, and the north of Africa.

**BEDWIN**, a borough-town of Wiltshire, about 18 miles north-west of Salisbury, in  $1^{\circ} 40'$  W. long. and  $51^{\circ} 25'$  N. lat.

**BEE**,

**BEE**, in zoology. See **APIS**.

**BEE-EATER**, in zoology. See **MEROPS**.

**BEECH**, in botany. See **FAGUS**.

**BEECH-GALLS**, hard protuberances found on the leaves of the beech, wherein are lodged the maggots of a certain fly.

**BEECH-MAST**, the fruit of the beech-tree, said to be good for fattening hogs, deer, &c.

**BEECH-OIL**, an oil drawn by expression from the mast of the beech-tree, after it has been shelled and pounded. This oil is very common in Picardy, and used there, and in other parts of France, instead of butter; but most of those who take a great deal of it, complain of pains and a heaviness in the stomach.

**BEELE**, a kind of pick-ax, used by the miners for separating the ores from the rocks in which they lie: This instrument is called a *tubber* by the miners of Cornwall.

**BEER**, a common and well-known liquor, made with malt and hops. See **BREWING**, &c.

**BERR**, among weavers, a term that signifies nineteen ends of yarn, running all together the whole length of the cloth.

**BEER-MEASURE**. See **MEASURE**.

**BEESTING**, a term used by country-people for the first milk taken from a cow after calving.

**BEEF**, in botany. See **BETA**.

**BEEFLE**, in the history of insects. See **SCARABÆUS**.

**BEEFLE** also denotes a wooden instrument for driving piles, &c. It is likewise called a *flamper*, and by paviors a *rammer*.

**BEFORT**, a town of Alsace, subject to France, and situated about 15 miles north of Basil, in 7° E. long. and 47° 35' N. lat.

**BEG**, or **BEY**, in the Turkish affairs. See **BEY**.

**BEGGAR**, one who begs alms.

**BEGHARDI**, a certain sect of heretics, which arose in Germany, and in the Low Countries, about the end of the 13th century. They made profession of the monastical life, without observing celibacy; and maintained, that man could become as perfect in this life, as he shall be in heaven; that every intellectual nature is of itself happy, without the succour of grace; and that he who is in this state of perfection ought to perform no good works, nor worship the host.

**BEGLERBEG**, a governor of one of the principal governments in the Turkish empire. There are two sorts of beglerbegs: The one have a certain revenue assigned upon the cities, boroughs, and villages of their government, which they raise by power of the commission granted to them by the sultan; the others have a certain rent paid by the treasurer of the grand signior. They are become almost independent; and have under their jurisdiction several sangiacs or particular governments, and begs, agas, and other officers who obey them.

**BEGONIA**, in botany, a genus of the polygamia monœcia class. The hermaphrodite flower has no calix; the corolla has 5 petals; it has many stamina, and 3 styli; the male has likewise no calix; the corolla has

4 petals; and has a great number of stamina. There is but one species of begonia, viz. the obliqua, a native of India.

**BEGUARDI**, or **BEGHARDI**. See **BEGHARDI**.

**BEGUINS**, congregations of devout young women, who maintain themselves by the work of their hands, leading a middle kind of life between the secular and religious. These societies consist of several houses placed together in one inclosure, with one or more churches, according to the number of beguins.

There is in every house a prioress, without whose leave they cannot stir out. Their vow is conceived in these terms: *I promise to be obedient and chaste, as long as I continue in this beguinage*. They observe a three years novitiate before they take the habit, and the rector of the parish is their superior, but can do nothing without the advice of eight beguins.

They are established in several parts of Flanders.

**BEHEADING**, a capital punishment, inflicted by cutting off the head with an ax, sword, &c.

Among the Romans, beheading was a military punishment, performed at first with an ax, but afterwards with a sword, as done at present in Holland and France. In England the ax is preferred; and in Scotland they use, for this purpose, a machine called a *maiden*.

**BEHEN**, in botany. See **CUCUBALUS**.

**BEJA**, a city of Alentejo, in Portugal, in 8° 40' W. long. and 37° 55' N. lat.

**BEICHLINGEN**, a city of Thuringia, in the circle of Upper Saxony in Germany, in 11° 25' E. long. and 51° 20' N. lat.

**BEILA**, a town of Piedmont in Italy, about thirty-two miles north of Turin; E. long. 7° 45', and N. lat. 45°.

**BEILSTEIN**, a town of the landgraviate of Hesse in Germany, situated about 32 miles north of Mentz, in 8° E. long. and 50° 30' N. lat.

**BEIZA**, or **BEIZATH**, in Hebrew antiquity, a word signifying an egg, was a certain measure in use among the Jews. The beiza was likewise a gold coin, weighing forty drachms, among the Persians, who gave out, that Philip of Macedon owed their king Darius a thousand beizaths or golden eggs, for tribute-money; and that Alexander the Great refused to pay them, saying, that the bird which laid these eggs was flown into the other world.

**BELAC**, a small city of la Marche, in the Lyonnais; E. long. 1° 15', and N. lat. 46° 15'.

**BELAY**, in the sea-language, is to make fast the ropes in their proper places.

**BELCASTRO**, a city of Calabria, in the kingdom of Naples; E. long. 17° 15', and N. lat. 39° 15'.

**BELCOE**, a town of Ireland, situated on Loch-niany, in the county of Farmanagh, and province of Ulster; W. long. 8° 6', and N. lat. 54° 5'.

**BELEM**, a fortress on the north side of the river Tagus, about three miles west of Lisbon.

**BELFMENTES**, in natural history, a substance concerning the nature of which there has been much dispute. Some maintain it to be a petrified animal; others

will have it to be a fossil, &c. Linnæus refers the belemnites to the class of shells with several cells. The shape of the belemnites is sometimes conical, sometimes cylindrical; and they commonly consist of a black horny kind of substance. Their length is from two to eight inches; and their diameter from the sixth part of an inch to two or three inches. The inward part consists of rays; and there is generally a cell at the large end, and a furrow running from top to bottom. Dr Plot says, that when scraped or burnt, they smell like horn. They are generally hollow about an inch deep, and filled with gravel. Their colour is various; some are ash-coloured, others bluish. They are commonly found in gravel-pits. See Plate LI. fig. 21.

**BELEZERO**, the capital of a province of the same name, in Russia, situated on the south-east shore of the white lake; E. long. 36°, and N. lat. 60° 50'.

**BELFAST**, a port-town of Ireland, in the county of Antrim, and province of Ulster; W. long. 6° 15', N. lat. 54° 38'.

**BELFRY**, that part of a steeple where bells are hung, or the timber frame whereby they are supported.

**BELGARDEN**, a town of Eastern Pomerania, in Germany, subject to Prussia; E. long. 16° 5', and N. lat. 54°.

**BELGOROD**, the capital of a province of the same name, in Russia, situated almost in the middle of that empire; E. long. 37°, and N. lat. 51° 20'.

**BELGOROD** is also a fortified town of Bessarabia, in Turkey, situated on the Black-sea, at the mouth of the river Neister; E. long. 31°, and N. lat. 46° 30'.

**BELGRADE**, the capital of the province of Servia, in European Turkey, situated on the south side of the Danube, in E. long. 21° 20', and N. lat. 45°. It was yielded to the Turks in 1739.

**BELI oculus**, in natural history. See **OCULUS**.

**BELIEF**, the assent of the mind to the truth of any proposition. See **METAPHYSICS**.

**BELL**, a well known machine, ranked by musicians among the musical instruments of percussion.

The metal of which a bell is made, is a composition of tin and copper, or pewter and copper; the proportion of one to the other is almost twenty pounds of pewter, or twenty-three pounds of tin, to one hundred weight of copper.

Bell-metal is prohibited to be imported, as are hawk-bells, &c.

The constituent parts of a bell are the body or barrel, the clapper on the inside, and the ear or cannon on which it hangs to a large beam of wood.

**Diving-BELL**. See **PNEUMATICS**.

**BELL-foundery**. See **FOUNDERY**.

**BELL-flower**, in botany. See **CAMPANULA**.

**BELL-weed**, in botany. See **JACEA**.

**BELLADONA**, in botany, the trivial name of a species of atropa. See **ATROPA**.

**BELLCLAIRE**, a town of Ireland, in the county of Sligo, and province of Connaught, about twenty-three miles south-west of Sligo; W. long. 9° 5', and N. lat. 53° 55'.

**BELLE**, a town in French Flanders, about twelve miles north-east of Lille; E. long. 2° 40', N. lat. 50° 45'.

**BELLENTS**, a city of Switzerland, in 9° E. long. and 46° N. lat.

**BELLESME**, a town of the Orleanois in France; E. long. 40', N. lat. 48° 30'.

**BELLEY**, a town of Burgundy in France, situated on the frontiers of Savoy, about sixteen miles north-west of Chambery; E. long. 5° 20', N. lat. 45° 40'.

**BELLEVILLE**, a town of the Lyonois, in France, about nineteen miles north of Lyons; E. long. 4° 45', N. lat. 46° 8'.

**BELLIDIATRUM**, in botany, a synonyme of a species of doricum. See **DORONICUM**.

**BELLIDIODES**, in botany, a synonyme of a species of chrysanthemum. See **CHRYSANTHEMUM**.

**BELLING** of *hops* denotes their opening and expanding themselves. See **HOPS**.

**BELLIS**, or **DAISY**, in botany, a genus of the syngenesia polygamia superflua class. The receptacle of the bellis is naked and conical; it has no pappus; the calix is hemispherical, with squamæ of an equal size; and the seeds are oval. There are two species; viz. the hortensis, a native of several parts of Europe; and the perennis, or common daisy, a native of Britain. The leaves of the perennis have a subacid taste, and are recommended as vulneraries, and in asthma and hectic fevers.

**BELLEISLE**, an island on the coast of Britany, in France; in 3° W. long. and 47° 20' N. lat.

**BELLISLE** is also an island of America, on the coast of New Britain.

It gives name to the streights which separate Newfoundland from New Britain; in 58° W. long. and 52° N. lat.

**BELLON**, a distemper common in countries where they smelt lead-ore. It is attended with languor, intolerable pains and sensation of gripings in the belly, and generally costiveness.

Beasts, poultry, &c. as well as men, are subject to this disorder: Hence a certain space round the smelting houses is called bellon-ground, because it is dangerous for an animal to feed upon it.

**BELLONARII**, in Roman antiquity, the priests of Bellona, who, in honour of that goddess, used to make incisions in their body; and, after having gathered the blood in the palm of their hand, give it to those who were partakers of their mysteries.

**BELLONIA**, in botany, a genus of the pentandria monogynia class. The corolla is rotated; the capsule consists of one cell inclosing many seeds. There is but one species, viz. the aspera, a native of America.

**BELLOWING**, among sportsmen, denotes the noise of roes in rutting-time.

**BELLOWS**, a machine so contrived as to expire and inspire the air by turns, by enlarging and contracting its capacity.

This machine is used in chambers and kitchens, in forges, furnaces, and founderies, to blow up the fire: It serves also for organs and other pneumatic instruments.



ments, to give them a proper degree of air: All these are of various constructions, according to their different purposes; but in general they are composed of two flat boards, sometimes of an oval, sometimes of a triangular figure: Two or more hoops, bent according to the figure of the boards, are placed between them; a piece of leather, broad in the middle, and narrow at both ends, is nailed on the edges of the boards, which it thus unites together; as also on the hoops which separate the boards, that the leather may be easier open and fold again; a tube of iron, brass, or copper is fastened to the undermost board, and there is a valve within that covers the holes in the under-board to keep in the air.

Each pair of bellows imported is valued in the book of rates at three shillings and four pence, and pays duty  $7\frac{2}{8}d.$  whereof  $6\frac{2}{8}d.$  is drawn back on exportation. See PNEUMATICS.

**BELLUNA**, the capital of the Bellunese, in the dominions of Venice, about 40 miles north of Padua; in  $12^{\circ} 40'$  E. long. and  $46^{\circ} 20'$  N. lat.

**BELLY**, in anatomy, the same with what is more usually called abdomen. See p. 256.

**BELLOAR**, a stone, otherwise called *widuris*. See *WIDURIS*.

**BELOMANCY**, a sort of divination by means of arrows, practised in the east, and particularly in Arabia.

Belomancy has been performed different ways, whereof one was this: Suppose a parcel of arrows, eleven or more of them being put into a bag; these were afterwards drawn out, and according as they were marked or not, they judged of future events.

**BELONE**, in ichthyology, the trivial name of a species of efox. See *ESOX*.

**BELT**, in the military art, a leathern girdle for sustaining the arms, &c. of a soldier.

**BELTS**, in astronomy, two zones, or girdles, surrounding the body of the planet of Jupiter, more lucid than the rest, and of unequal breadth.

**BELTS**, in geography, certain freights between the German ocean and the Baltic. The belts belong to the king of Denmark, who exacts a toll from all ships which pass through them, excepting those of Sweden, which are exempted.

**BELTURBET**, a town of Ireland, in the county of Cavan in the province of Ulster, situated upon the river Earn, about eight miles north of Cavan; in  $7^{\circ} 35'$  W. long. and  $54^{\circ} 7'$  N. lat.

**BELTZ**, the capital of a palatinate of the same name, in the province of Red Russia, in Poland; in  $24^{\circ}$  E. long. and  $50^{\circ} 5'$  N. lat.

**BELVIDERE**, in the Italian architecture, &c. denotes either a pavilion on the top of a building, or an artificial eminence in a garden; the word literally signifying a *sine prospect*.

**BELVIDERE**, in geography, the capital of a province of the same name, on the western coast of the Morea, in  $22^{\circ}$  E. long. and  $37^{\circ}$  N. lat.

**BEMA**, in ecclesiastical antiquity, denoted the most sacred part of a church, or that where the altar stood.

It was also used for the bishop's throne, as well as for the ambo. See *AMBO*.

**BEMBER**, a chain of mountains, dividing India from Tartary.

**BEMSTER**, a market-town of Dorsetshire, about twelve miles north-west of Dorchester, situated in  $2^{\circ} 50'$  W. long. and  $50^{\circ} 45'$  N. lat.

**BEN**. See *BEHEN*.

**BEN of Judea**, a name sometimes used for benzoin. See *BENZOIN*.

**BENAVARRE**, or *BENHUARRI*, a town of Aragon in Spain, situated in  $10'$  E. long. and  $42^{\circ} 5'$  N. lat.

**BENBECULA**, one of the western isles of Scotland.

**BENCALIS**, or *BANCALIS*. See *BANCALIS*.

**BENCH**, or *BANC*, in law. See *BANC*.

*Free BENCH* signifies that estate in copyhold-lands, which the wife, being espoused a virgin, has, after the decease of her husband, for her dower, according to the custom of the manor. As to this free-bench, several manors have several customs; and in the manors of East and West Enbourne, in the county of Berks, and other parts of England, there is a custom, that when a copyhold tenant dies, the widow shall have her free-bench in all the deceased husband's lands, whilst she lives single and chaste; but if she commits incontinency, she shall forfeit her estate: Nevertheless, upon her coming into the court of the manor, riding on a black ram, and having his tail in her hand, and at the same time repeating a form of words prescribed, the steward is obliged, by the custom of the manor, to readmit her to her free-bench.

*Widow's BENCH*. See *WIDOW*.

*Amiable BENCH*. See *AMIABLE*.

**BENCHERS**, in the Inns of court, the senior members of the society, who are invested with the government thereof.

**BENCOOLEN**, a town and fort on the south-west coast of Sumatra, belonging to the E. India company, from whence great quantities of pepper are imported. It is situated in  $101^{\circ}$  E. long. and  $4^{\circ}$  S. lat.

**BEND**, in heraldry, one of the nine honourable ordinaries, containing a third part of the field when charged, and a fifth when plain. It is sometimes, like other ordinaries, indented, ingrailed, &c. and is either dexter or sinister.

**BEND dexter** is formed by two lines drawn from the upper part of the shield on the right, to the lower part of the left, diagonally. It is supposed to represent a shoulder-belt, or a scarf, when worn over the shoulder. See Plate LI. fig. 11.

**BEND sinister** is that which comes from the left side of the shield to the right: This the French heralds call a *barre*. *In BEND*, is when any things, borne in arms, are placed obliquely from the upper corner to the opposite lower, as the bend lies.

*Parti per BEND*; *Point in BEND*, &c. See *PARTI* and *POINT*.

**BENDER**, a town of Beffarabia, in European Turkey, situated on the river Neister, in  $29^{\circ}$  E. long. and  $46^{\circ} 40'$  N. lat.

**BEN.**

**BENDERICK**, a sea-port town, situated on the Persian gulf.

**BENDIDIA**, a festival, not unlike the Bacchanalia, celebrated by the Athenians in honour of Diana.

**BENDING**, in a general sense, the reducing a straight body into a curve, or giving it a crooked form.

The bending of timber-boards, &c. is effected by means of heat, whereby their fibres are so relaxed that you may bend them into any figure.

**BENDING**, in the sea-language, the tying two ropes or cables together: Thus they say, *bend the cable*, that is, make it fast to the ring of the anchor; *bend the sail*, make it fast to the yard.

**BENDITTO**, a town of the Mantuan in Italy, situated near the south shore of the river Po, about twelve miles south-east of Mantua, in 11° 20' E. long. and 45° N lat.

**BENDLET**, in heraldry, the same with coticce. See **COTTICE**.

**BENDS**, in a ship, the same with what is called wails, or wales; the outmost timbers of a ship's side, on which men set their feet in climbing up. They are reckoned from the water, and are called the first, second, or third bend. They are the chief strength of a ship's sides, and have the beams, knees, and foot-hooks bolted to them.

**BENDY**, in heraldry, is the field divided into four, six, or more parts, diagonally, and varying in metal and colour.

The general custom of England is to make an even number, but in other countries they regard it not, whether even or odd. See Plate LI. fig. 12.

*Counter BENDY* is used by the French, to express what we ordinarily call bendy of six per bend sinister, counterchanged.

*Barry Bendy*. See **BARRY**.

*Paly Bendy*. See **PALY**.

**BENE**, or **DE BENE ESSE**. See **DE BENE ESSE**.

**BENCAPED**, among sailors. A ship is said to be benched when the water does not flow high enough to bring her off the ground, out of the dock, or over the bar.

**BENEDICITE**, among ecclesiastical writers, an appellation given to the song of the three children in the fiery furnace, on account of its beginning with the word *benedicite*.

**BENEDICTINS**, in church-history, an order of monks, who profess to follow the rules of St. Benedict.

The benedictins, being those only that are properly called monks, wear a loose black gown, with large wide sleeves, and a capuche, or cowl, on their heads, ending in a point behind. In the canon law, they are styled black friars, from the colour of their habit.

The rules of St. Benedict, as observed by the English monks before the dissolution of the monasteries, were as follows: They were obliged to perform their devotions seven times in twenty-four hours, the whole circle of which devotions had a respect to the passion and death of Christ: They were obliged always to go two and two together: Every day in lent they were obliged to fast till six in the evening, and abated of

their usual time of sleeping and eating; but they were not allowed to practise any voluntary austerity without leave of their superior: They never conversed in their refectory at meals, but were obliged to attend to the reading of the scriptures: They all slept in the same dormitory, but not two in a bed; they lay in their cloaths: For small faults they were shut out from meals; for greater, they were debarred religious commerce, and excluded from the chapel; and as to incorrigible offenders, they were excluded from the monasteries. Every monk had two coats, two cowls, a table-book, a knife, a needle, and a handkerchief; and the furniture of their bed was a mat, a blanket, a rug, and a pillow.

**BENEDICTION**, or **BLESSING**. The Hebrews, under this name, understand the present usually sent from one friend to another, as also the blessing conferred by the patriarchs, on their death-beds, upon their children.

The privilege of benediction was one of those early instances of honour and respect paid to bishops in the primitive church. The custom of bowing the head to them, and receiving their blessings, was become universal. In the western churches there was anciently a kind of benediction which followed the Lord's prayer; and after the communion, the people were dismissed with a benediction.

**BENEDICTUS**, among physicians, an epithet given to several medicines, on account of their lenitive qualities; thus we meet with *aqua benedicta*, *benedictum laxativum*, *vinum benedictum*, &c.

**BENEDITIO SACCO**. See **SACCO**.

**BENEFICE**, in an ecclesiastical sense, a church endowed with a revenue for the performance of divine service; or the revenue itself assigned to an ecclesiastical person, by way of stipend, for the service he is to do that church.

All church-preferments, except bishoprics, are called benefices; and all benefices are, by the canonists, sometimes styled dignities: But we now ordinarily distinguish between benefice and dignity, applying dignity to bishoprics, deaneries, archdeaconries, and prebendaries; and benefice to parsonages, vicarages, and donatives.

Benefices are divided by the canonists into simple and sacerdotal: In the first there is no obligation to read prayers, sing, &c. such are canonries, chaplainships, chantries, &c.: The second are charged with the cure of souls, or the direction and guidance of consciences; such are vicarages, rectories, &c.

The Romanists again distinguish benefices into regular and secular.

Regular or titular benefices are those held by a religious, or a regular, who has made profession of some religious order; such are abbey, priories, convents, &c.; or rather, a regular benefice is that which cannot be conferred on any but a religious, either by its foundation, by the institution of some superior, or by prescription: For prescription, forty years possession by a religious makes the benefice regular.

Secular benefices are only such as are to be given to secular priests, *i. e.* to such as live in the world, and are

are not engaged in any monastic order. All benefices are reputed secular, till the contrary is made to appear. They are called secular benefices, because held by seculars; of which kind are almost all cures.

**BENEFIT of Clergy.** See **CLERGY**.

**BENESCHAW**, the name of two towns; the one in the kingdom of Bohemia, and the other in Silesia.

**BENEVENTE**, a town of Leon, in Spain, situated on the river Esta, about 40 miles south of the city of Leon, in 6° W. long. and 42° 10' N. lat.

**BENEVENTO**, the capital of the Farther Principate, in the kingdom of Naples, about 34 miles north-east of the city of Naples; situated in 15° 30' E. long. and 41° 15' N. lat.

**BENEVOLENCE**, in morals, signifies the love of mankind in general, accompanied with a desire to promote their happiness. See **MORALS**.

**BENEVOLENTIA regis habenda** is the ancient form of purchasing the king's pardon and favour, on submission, in order to be restored to place, title, or estate.

**BENFIELD**, a town of Alsace, in Germany, about 15 miles south of Strasburg; situated in 7° 30' E. long. and 48° 25' N. lat.

**BENGA**, one of the Molucca islands. See **MOLUCCA**.

**BENGAL**, the most easterly province of the Mogul's empire, lying at the bottom of a large bay, which takes its name from this province.

It is one of the most fertile provinces in India, being yearly overflowed by the Ganges, as Egypt is by the Nile.

**BENGUELA**, a kingdom upon the western coast of Africa between Angola and Jaga. It is also the name of the capital of that kingdom.

**BENJAMIN**, the same with benzoin. See **BENZOIN**.

**BENJAR**, the most considerable river of the island Borneo, which, arising near the middle of that island, runs southwards, and falls into the great South Sea.

**BENIN**, the capital of a country of the same name, on the coast of Guinea; situated in 5° E. long. and 7° 30' N. lat.

**BENSHEIM**, a town of Germany, situated on the east-side of the river Rhine, about 10 miles east of Worms, in 8° 30' E. long. and 49° 40' N. lat.

**BENTHEIM**, the capital of a county of the same name, in the circle of Westphalia; situated in 7° 15' E. long. and 52° 25' N. lat.

**BENTIVOGLIO**, a town in the territory of Bologna, in Italy, about 10 miles north of that city, situated in 12° E. long. and 44° 30' N. lat.

**BENZOIN**, in materia medica, a concrete resinous juice, obtained from a large tree growing naturally in both the Indies. The resin is brought from the East Indies in large masses, composed of white and light-brown pieces, with yellowish specks: It easily breaks betwixt the hands. That which is whitest is most esteemed. It has very little taste; but its smell is very fragrant and agreeable, especially when heated. The principal use of benzoin is in perfumes, and as a cosmetic; and enters in substance only into one officinal composition, the balsamum tranmaticum. But its flowers, which is a white saline concrete obtained by committing it to

the fire in proper vessels, are recommended in disorders of the breast; and in this intention they are made an ingredient in the pægoric elixir, pectoral elixir, and pills, and in the troches of sulphur.

**BERAMS**, a coarse cloth, all made with cotton-thread, which comes from the East Indies, and particularly from Surat.

**BERAR**, an inland province of India, on this side the Ganges, lying westward of Orissa.

**BERAUN**, a town of Bohemia, situated in 14° E. long. and 50° 2' N. lat.

**BERAY**, a town of Normandy, in France, situated in 1° 20' W. long. and 49° 6' N. lat.

**BERBERII**, the **PALSY**, in medicine. See **PALSY**.

**BERBERIS**, in botany, a genus of the hexandria monogynia class. The calix consists of six leaves or pieces; the petals are six, with two glands at the unguis; it has no stylus; and the berry contains two seeds. There are two species, viz. the vulgaris, or barberry or pipperidge-bush, a native of Britain; and the cretica, a native of Candia. The inner bark, which is bitter, is said to be of use in the jaundice. The berries, which are gratefully acid, have been given with success in bilious fluxes, and diseases proceeding from heat, acrimony, or thinness of the juices.

**BERCHEROIT**, or **BERKOITZ**, a weight used at Archangel, and in all the Russian dominions, to weigh such merchandizes as are heavy and bulky: It weighs about 364 pounds English avoirdupois weight.

**BERENGARIANS**, a religious sect of the XIth century, which adhered to the opinion of Berengarius, who, even in those days, strenuously asserted, that the bread and wine in the Lord's supper is not really and essentially, but only figuratively, changed into the body and blood of Christ.

**BERENICE**, a port-town of Egypt, now called Suez.

**BERENICE'S HAIR**, *coma Berenices*. See **COMA**.

**BERE-REGIS**, a market-town in Dorsetshire, about 10 miles north-east of Dorchester, in 2° 20' W. long. and 50° 40' N. lat.

**BERESOWA**, a town of Muscovy, in Samogitia, situated upon the river Oby.

**BERG**, a dutchy of Westphalia, in Germany, lying on the eastern shore of the river Rhine, which separates it from Cologne.

**BERG of St. Winos**. See **WINOXBERG**.

**BERGAMO**, a town in the territories of Venice, in Italy, about 25 miles north-east of Milan, in 10° E. long. and 45° 40' N. lat.

**BERGAMOT**, the name of a fragrant essence extracted from a fruit which is produced by ingrafting a branch of a lemon-tree upon the stock of a bergamot-pear. It is also the denomination of a coarse tapestry, manufactured with flocks of silk, wool, cotton, hemp, ox, cow, or goats hair, and supposed to be invented by the people of Bergamo.

**BERGAS**, a town of European Turkey, in Romania, in 28° E. long. and 41° 17' N. lat.

**BERGEN**, the capital of a province of the same name, in Norway: It is a considerable port-town on the German ocean, in 6° E. long. and 60° N. lat.

**BERGEN** is also the name of the capital of the isle of Rugen, on the coast of Pomerania, in  $14^{\circ}$  E. long. and  $54^{\circ} 15'$  N. lat.

**BERGEN-OP-ZOOM**, a fortified town of Dutch Brabant, about 20 miles north of Antwerp, in  $4^{\circ} 5'$  E. long. and  $51^{\circ} 30'$  N. lat.

**BERGERÄCK**, a city of Guienne in France situated on the river Dordonne, about 40 miles east of Bourdeaux, in  $20^{\circ}$  E. long. and  $44^{\circ} 55'$  N. lat.

**BERG-GRUEN**, a kind of green ochre, used in painting.

**BERGHMOT**, an assembly, or court, held upon a hill in Derbyshire, for deciding controversies among the miners.

**BERGZABERN**, a town of Lower Alsace, about five miles south of Landau, in  $8^{\circ}$  E. long. and  $49^{\circ} 5'$  N. lat. It is subject to France.

**BERKSHIRE**, a county in England, lying on the south side of the river Thames, opposite to Oxfordshire and Buckinghamshire. It gives the title of earl to a branch of the Howard family.

**BERLIN**, the capital of the king of Prussia's dominions in Germany, situated on the river Spree, in the marquisate of Brandenburg; in  $14^{\circ}$  E. long. and  $52^{\circ} 30'$  N. lat.

**BERLIN** is also the name of a kind of chariot, so called from the city of Berlin.

**BERME**, in fortification, a space of ground left at the foot of the rampart, on the side next the country, designed to receive the ruins of the rampart, and prevent their filling up the fosse. It is sometimes palisaded, for the more security; and in Holland it is generally planted with a quick-set hedge. It is also called *ti-ziere*, *relais*, *forcland*, *retraite*, *païs de souris*, &c.

**BERMUDA-ISLANDS**, a cluster of very small islands, in the Atlantic ocean, lying almost in the shape of a shepherd's hook, in  $65^{\circ}$  W. long. and  $32^{\circ} 30'$  N. lat.

**BERMUDIANA**, in botany, a synonyme of the ixia. See **IXIA**.

**BERN**, a town of Bohemia, about 15 miles west of Prague, in  $14^{\circ}$  E. long. and  $50^{\circ}$  N. lat.

**BERN** is also the name of a city and canton in Switzerland; the former being situated in  $7^{\circ} 20'$  E. long. and  $47^{\circ}$  N. lat.

The Canton of Bern is by far the most extensive and powerful of all Switzerland: Their government is aristocratical, and their religion protestant, according to the Presbyterian form.

**BERNARDIA**, in botany, a synonyme of the adelia. See **ADELIA**.

**BERNARDINES**, an order of monks, founded by Robert abbot of Moleme, and reformed by St. Bernard. They wear a white robe with a black scapulary; and when they officiate they are clothed with a large gown which is all white, and hath great sleeves, with a hood of the same colour.

**BERNAW**, the name of three towns in Germany, one in the electorate of Brandenburg, another in the bishopric of Ratisbon, and the third in the Upper Palatinate.

**BERNBURG**, a town of Anhalt, in the circle of Upper Saxony, situated in  $12^{\circ} 20'$  E. long. and  $51^{\circ} 50'$  N. lat.

**BERNERA**, one of the western isles of Scotland, lying in lat.  $56^{\circ} 48'$ .

**BERNICOLA**, in ornithology, the trivial name of a species of anas. See **ANAS**.

**BERNICLE**, in zoology. See **LEPAS**.

**BERRY**. See **BACCA**.

**BERRY**, in geography, a territory of the Orleansois, having Tourain on the west, and the Nivernois on the east.

**BERRY-POINT**, a cape at the entrance of Torbay in Devonshire.

**BERSELLO**, or **BRESELLO**, a town of the Modenesa, in Italy, situated on the river Po, about 14 miles north-east of Parma; in  $11^{\circ}$  E. long. and  $44^{\circ} 40'$  N. lat.

**BERTH**, or **BIRTH**, among sailors. See **BIRTH**.

**BERTRAND**, or **ST. BERTRAND**, a city of Gascony, in France, situated on the river Garonne, about 45 miles south of Tolouse, in  $30^{\circ}$  E. long. and  $43^{\circ} 15'$  N. lat.

**BERVY**, a sea-port town and borough of Scotland, situated on the German ocean, about 22 miles south-west of Aberdeen, in  $2^{\circ} 5'$  W. long. and  $56^{\circ} 50'$  N. lat.

**BERWICK**, a borough-town on the borders of England and Scotland, situated on the north side of the river Tweed, in  $1^{\circ} 40'$  W. long. and  $55^{\circ} 30'$  N. lat. It sends two members to parliament.

**North-BERWICK**, a town of Scotland, situated at the entrance of the frith of Forth, about 17 miles east of Edinburgh, in  $2^{\circ} 27'$  W. long. and  $56^{\circ} 5'$  N. lat.

**BERYL**, in natural history, called by our lapidaries *aqua marina*, is a pellucid gem of a bluish green colour, found in the East Indies and about the gold mines of Peru: We have also some from Silesia, but what are brought from thence are oftener coloured crystals than real beryls; and when they are genuine, they are greatly inferior both in hardness and lustre to the oriental and Peruvian kinds.

The beryl, like most other gems, is met with both in the pebble and columnar form, but in the latter most frequently. In the pebble form it usually appears of a roundish but flattened figure, and commonly full of small flat faces, irregularly disposed. In the columnar or crystalline form it always consists of hexangular columns, terminated by hexangular pyramids. It never receives any admixture of colour into it, nor loses the blue and green, but has its genuine tinge in the degrees from a very deep and dusky to the palest imaginable of the hue of sea-water.

The beryl, in its perfect state, approaches to the hardness of the granet, but it is often softer; and its size is from that of a small tare to that of a pea, a horse-bean, or even a walnut. It may be counterfeited by reducing burnt copper to an impalpable powder, and melting it with crystalline glass or calcined crystal, in the proportion of one dram to a pound of glass.

**BERYL-crystal**, in natural history, a species of what Dr Hill calls *Alipomacrofylla*, or imperfect crystals, is of an extreme pure, clear, and equal texture, and scarcely ever subject to the slightest films or blemishes. It is ever constant to the peculiarity of its figure, which is that of a long and slender column, remarkably tapering.

- ing towards the top, and very irregularly hexangular. It is of a very fine transparence; and naturally of a pale brown; and carries so evident marks of distinction from all brown crystals, that our lapidaries call it, by way of eminence, the *beryl-crystal*, or simply the *beryl*.
- BES**, or **BESSIS**, in Roman antiquity, two thirds of the as. See **AS**.
- BES** also denotes two thirds of the jagerum. See **JAGERUM**.
- BESAILE**, signifies the father of a grand-father.
- BESAILE**, in law, a writ that lies where the great-grandfather was seized in fee of any lands, &c. at the time of his death; and after his decease, a stranger enters thereon, the same day, and keeps out the heir.
- BESANCON**, the capital of Franche Comté in France, situated in 6° E. long. and 47° 20' N. lat.
- BESANT**, or **BEZANT**, a coin of pure gold, of an uncertain value, struck at Byzantium, in the time of the Christian emperors; from hence the gold offered by the king at the altar, is called *besant* or *bisant*.
- BESANTS**, in heraldry, round pieces of gold, without any stamp, frequently borne in coats of arms. See Plate LI. fig. 14.
- BESIERS**, a city of lower Languedoc in France, about two miles north of the Mediterranean, and fifteen north-east of Narbonne, in 3° E. long. and 43° 25' N. lat.
- BESLERIA**, in botany, a genus of the didynamia angiospermia class. The calix is divided into five parts; and the berry globular, and contains many seeds. The species are three, *viz.* the *melitrifolia*, the *lutea*, and the *cristata*, all natives of America.
- BESORCH**, a coin of tin, or some alloyed metal, current at Ormus, at the rate of  $\frac{7}{27}$  parts of a farthing sterling.
- BESSARABIA**, a province of Turkey in Europe, lying about the several mouths of the Danube.
- BESSIS**. See **BES**.
- BESSY**, one of the Molucca islands, situated in the Indian ocean, in 1° 50' S. lat.
- BESTAIL**, or **BESTIAL**, in ancient statutes, all kinds of beasts, or cattle, especially those purveyed for the king's provision.
- BESTIARII**, in Roman antiquity, such as fought against beasts, or those who were exposed to them by sentence of the law. There were four kinds of *bestiarii*; the first were those who made a trade of it, and fought for money; the second were such young men as, to shew their strength and dexterity in managing their arms, fought against beasts; the third kind was, where several *bestiarii* were let loose at once, well armed, against a number of beasts; and the fourth kind were those condemned to the beasts, consisting either of enemies taken prisoners in war, or as being slaves, and guilty of some enormous crime; those were all exposed naked, and without defence.
- BESTRICIA**, a city of Transylvania, remarkable for the gold mines near it; it is situated in 22° E. long. and 48° N. lat.
- BETA**, the beet, in botany, a genus of the pentandria digynia class. The calix has four leaves; it has no corolla; the seeds are shaped like kidneys, and are situated within the base of the calix. There are two species, *viz.* the *maritima* or sea-beet, a native of Britain; and the *vulgaris* or green beet of Bauhinus, which is chiefly cultivated for culinary use. Decoctions of the *vulgaris* loosen the belly; and hence have been ranked among the emollient herbs. The juice expressed from the roots is a powerful errhine.
- BETANCOS**, a city of Galicia in Spain, in 8° 50' W. long. and 43° 15' N. lat.
- BETAU**. See **BETUE**.
- BETEL**, or **BETLE**, in botany, the trivial name of a species of piper. See **PIPER**.
- BETELFAGUI**, a town of Arabia Felix, about thirty-five leagues from Mocha.
- BETHLEHEM**, once a flourishing city of Palestine, but now only a poor village, is still much frequented, as being the place of our Saviour's birth; it is situated in 36° E. long. and 31° 30' N. lat.
- BETHLEHEM** is also the name of a town of Brabant, in the Austrian Netherlands, about two miles north of Louvain, situated in 4° 35' E. long. and 51° N. lat.
- BETHLEHEMITES**, in church-history, a religious order, called also *star-bearers*, because they were distinguished by a red star with five rays, which they wore on their breast, in memory of the star that appeared to the wise men, and conducted them to Bethlehem.
- BETHUNE**, a little fortified town of Artois, in the French Netherlands, about thirteen miles north of Arras, situated in 2° 35' E. long. and 50° 32' N. lat.
- BETLIS**, a city in the north of Curdistan, situated on a steep rock, at the south end of the lake Van, on the frontiers of Persia and Turkey, in 45° E. long. and 37° 30' N. lat.
- BETONY**, in botany, the English name of the *betonica*, and of several species of *veronica*. See **BETONICA** and **VERONICA**.
- BETROTHMENT**, among civilians, the same with *espousals*.
- BETUE**, or **BETAU**, a territory in Dutch Guelderland, between the rivers Maese and Lech, supposed to be the ancient Batavia.
- BETULA**, or **BIRCH-tree**, in botany, a genus of the monœcia tetrandria class. The calix of the male flower has but one trifid leaf, and incloses three flowers; the corolla consists likewise of one leaf cut into four segments. The calix of the female is trifid, and incloses two flowers; and the seed is membranous, and alated on each side. The species are five, *viz.* the *alba* or birch-tree, a native of Britain; the *nigra*, and *lenta*, both natives of America; the *nana*, a native of Lapland, Russia, and Sweden; and the *alnus*, likewise a native of Lapland. The bark of the *alba*, or common birch-tree, is a highly inflammable substance; but its medical virtues are little known. Upon boring the trunk in the the beginning of spring, a sweetish juice issues forth in great quantities; one branch will bleed an English gallon or more in a day. This juice is chiefly recommended in scorbutic disorders, and other

foulnesses of the blood: Its most sensible effect is to promote the urinary discharge.

**BEVECUM**, a town of Brabant in the Austrian Netherlands, about seven miles south of Louvain, situated in  $4^{\circ} 45'$  E. long. and  $50^{\circ} 45'$  N. lat.

**BEVEL**, among masons, carpenters, &c. a kind of square, one leg whereof is frequently crooked, according to the sweep of an arch or vault. It is moveable on a centre, and so may be set to any angle.

**BEVEL-angle**, any other angle besides those of ninety or forty-five degrees. See **ANGLE**.

**BEVELAND**, the name of two islands, in the province of Zealand, in the United Netherlands.

The are called North and South Beveland; and lie between the eastern and western branches of the Scheld.

**BEVERLY**, a borough-town of Yorkshire, about seven miles north of Hull, in  $12'$  W. long. and  $53^{\circ} 50'$  N. lat. It sends two members to parliament.

**BEVILE**, in heraldry, a thing broken or opening like a carpenter's rule: Thus we say, he beareth argent, a chief bevilé, vert, by the name of *berverlis*. See Plate LI. fig. 13.

**BEUTHEN**, the name of two towns in Silesia, one of which is famous for a silver mine.

**BEWDLEY**, a borough-town of Worcestershire, situated on the river Severn, about twelve miles north of Worcester, in  $2^{\circ} 20'$  W. long. and  $52^{\circ} 25'$  N. lat. It sends only one member to parliament.

**BEWITS**, in falconry, pieces of leather, to which a hawk's bells are fastened, and buttoned to his legs.

**BEXOQUILLO**, a name sometimes given to the white ipecacuanha.

**BEY**, among the Turks, signifies a governor of a country or town. The Turks write it *begh*, or *bek*, but pronounce it *bey*.

This word is particularly applied to a lord of a banner, whom, in the same language, they call *sangiac-beg* or *bey*. Every province in Turkey is divided into seven sangiacs, or banners, each of which qualifies a bey; and these are all commanded by the governor of the province, whom they also call *begler-beg*, that is, lord of all the beghs or beys of the province: These beys are much the same as bannerets were formerly in England.

**BEY of Tunis**, the same with the dey of Algiers, is the prince or king of that kingdom.

**BEYLAN**, a town of Syria, upon the road from Aleppo to Constantinople.

**BEZANS**, cotton cloths, which come from Bengal; some are white, and others striped with several colours.

**BEZANTLER**, the branch of a deer's horns next below the brow-antler.

**BEZOAR**, in natural history, is a stony concretion found in the stomach of several animals of the goat kind. It is composed of concentric coats surrounding each other, with a small cavity in the middle, containing a bit of wood, straw, hair, or the like substances.

There are two kinds of bezoar. The first, which is brought from Persia and the East Indies, is found in the stomach of the capra bezoardica, and esteemed by physicians to be the best. It is called *oriental bezoar*, and is of a shining dark-green or olive-colour, and has an even smooth surface. On removing the outer coat, that which lies underneath is likewise smooth and shining. It is generally less than a walnut.

The second kind, called *occidental bezoar*, is brought from the Spanish West Indies, has a rough surface, and less of a green colour than the oriental. It is likewise much heavier, more brittle, and of a looser texture; the coats are thicker, and, on breaking, exhibits a number of striz curiously interwoven. The occidental is generally larger than a walnut, and sometimes as big as a goose-egg.

The great value of this stone in Persia and the East, and the little use it is found to be of in Europe, has made many suspect that the true kind is never brought to us. Many of them are indeed evidently made by art. The usual mark to distinguish its being of a good quality, is its striking a deep green colour on white paper that has been rubbed with chalk. But it is of little importance to say much on this subject. The stone is nothing more than a morbid concretion, much of the same nature with the human calculus, of no smell or taste, indigestible in the stomach of the animal in which it is found, and scarce capable of being acted upon by any of the juices of the human body; and, notwithstanding its many boasted virtues, it cannot be considered in any other light than as an absorbent of the weakest kind. However, bezoar, on account of its high price, if it serves no other purpose, is of an excellent use in the apothecaries bill.

**BEZOARDIC**, an appellation given to whatever partakes of the nature of bezoar; also to compound medicines whereof bezoar makes an ingredient.

**BIA**, in commerce, a name given by the Siamese to those small shells which are called cowries throughout almost all the other parts of the East Indies. See **COWRIES**.

**BIAFAR**, a kingdom of Africa in Negritia, bounded on the West by the kingdom of Benin, on the north by that of Medra, and on the east and south by the kingdom of Mujac.

**BIALOGOROD**, a town of Bessarabia, upon the Niester. It is likewise called Akerman; E. long.  $32^{\circ} 20'$ , N. lat.  $46^{\circ} 24'$ .

**BIALGRODKO**, the capital of the Ukraine, situated upon the river Pnetz.

**BIARU**, a cape on the north-east part of the island of Macassar, in the Indian Ocean.

**BIAS**, or **BIASS**, in a general sense, the inclination or bent of a person's mind to one thing more than another. It also signifies the lead or weight put into a bowl, that draws or turns the course of it any way to which the bias looks.

**BIATHANATI**, the same with suicides, or *felos de se*.

**BIBERSBERG**, a town of Upper Hungary, fifteen miles north of Presburg; E. long.  $17^{\circ} 30'$ , and N. lat.  $48^{\circ} 35'$ .

BIBIO,

**BIBIO**, in zoology, the trivial name of a species of tipula. See **TIPULA**.

**BIBITORY** *mufcle*, the same with the adductor oculi. See **ADDUCTOR**.

**BIBLE**, a name applied by Christians, by way of eminence or distinction, to the collection of sacred writings, or the holy scriptures of the Old and New Testament; known also by various other appellations, as, the Sacred Books, Holy Writ, Inspired Writings, Scriptures, &c. The Jews stiled the Bible (that is, the Old Testament) *mikra*, which signifies *Lesson*, or *Lecture*.

This collection of the sacred writings, containing those of the Old and New Testament, is justly looked upon as the foundation of the Jewish as well as the Christian religion. The Jews, it is true, acknowledge only the scriptures of the Old Testament, the correcting and publishing of which is unanimously ascribed, both by the Jews and Christians, to Ezra. Some of the ancient fathers, on no other foundation than that fabulous and apocryphal book, the second book of Esdras, pretend, that the scriptures were entirely lost and destroyed at the Babylonish captivity, and that Ezra restored them all again by divine revelation. What is certain is, that in the reign of Josiah there was no other book of the law extant besides that found in the temple by Hilkiah; from which original, by order of that pious king, copies were immediately written out, and search made for all the other parts of the scriptures, (2 Kings xxii.); by which means copies of the whole became multiplied among the people, who carried them with them into their captivity. After the return of the Jews from the Babylonish captivity, Ezra got together as many copies as he could of the Sacred writings, and out of them all prepared a correct edition, disposing the several books in their proper order, and settling the canon of scripture for his time. These books he divided into three parts. 1. The Law. 2. The Prophets. 3. The *Cetubim*, or *Hagiographia*, i. e. *The holy writings*.

I. The Law contains, 1. Genesis. 2. Exodus. 3. Leviticus. 4. Numbers. 5. Deuteronomy.

II The writings of the Prophets are, 1. Joshua. 2. Judges, with Ruth. 3. Samuel. 4. Kings. 5. Isaiah. 6. Jeremiah, with his Lamentations. 7. Ezekiel. 8. Daniel. 9. The twelve minor Prophets. 10. Job. 11. Ezra. 12. Nehemiah. 13. Esther.

III. And the *Hagiographia* consists of, 1. The Psalms. 2. The Proverbs. 3. Ecclesiastes. 4. The Song of Solomon. This division was made for the sake of reducing the number of the sacred books to the number of the letters in their alphabet, which amount to twenty-two. At present, the Jews reckon twenty-four books in their canon of scripture, in disposing of which the law stands as it did in the former division, and the prophets are distributed into the former and latter prophets.

The former prophets are,

Joshua, Judges, Samuel, Kings.

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The latter prophets are, Isaiah, Jeremiah, Ezekiel, and the twelve minor prophets.

And the *hagiographia* consist of,

The Psalms, the Proverbs, Job, the Song of Solomon, Ruth, the Lamentations, Ecclesiastes, Esther, Daniel, Ezra, the Chronicles.

Under the name of Ezra, they comprehend Nehemiah. It is true this order hath not always been observed, but the variations from it are of little or no moment.

The five books of the law are divided into fifty-four sections. This division many of the Jews hold to have been appointed by Moses himself; but others, with more probability, ascribe it to Ezra. The design of this division was, that one of these sections might be read in their synagogues every sabbath-day. The number was 54, because in their intercalated years, a month being then added, there were 54 sabbaths. In other years, they reduced them to 52, by twice joining together two short sections. Till the persecution of Antiochus Epiphanes, they read only the law; but the reading of it being then prohibited, they substituted in the room of it 54 sections out of the Prophets; and when the reading of the law was restored by the Maccabees, the section which was read every sabbath out of the law, served for their first lesson, and the section out of the prophets for their second. These sections were divided into verses, of which division, if Ezra was not the author, it was introduced not long after him, and seems to have been designed for the use of the Targumists, or Chaldee interpreters; for after the return of the Jews from the Babylonish captivity, when the Hebrew language had ceased to be their mother tongue, and the Chaldee grew into use instead of it, the custom was, that the law should be first read in the original Hebrew, and then interpreted to the people in the Chaldee language, for which purpose these shorter sections or periods were very convenient.

The division of the scriptures into chapters, as we at present have them, is of much later date. Some attribute it to Stephen Langton, archbishop of Canterbury, in the reigns of John and Henry III. But the true author of the invention was Hugo de Sancto Caro, commonly called Hugo Cardinalis, because he was the first Dominican that ever was raised to the degree of cardinal. This Hugo flourished about the year 1240. He wrote a comment on the scriptures, and projected the first concordance, which is that of the vulgar Latin Bible. The aim of this work being for the more easy finding out any word or passage in the scriptures, he found it necessary to divide the book into sections, and the sections into subdivisions; for till that time the vulgar Latin Bibles were without any division at all. These sections are the chapters into which the Bible hath ever since been divided. But the subdivision of the chapters was not then into verses, as it is now. Hugo's method of subdividing them was by the letters A, B, C, D, E, F, G, placed in the margin at an equal distance from each other, according to the length of the chapters. The subdivision of the chapters into verses, as they now stand in our Bibles, had its original from a famous Jewish rabbi, named Mordecai Nathan, about the year 1445. This rabbi, in imitation of Hugo Cardinalis, drew up a concordance

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ance to the Hebrew Bible, for the use of the Jews. But though he followed Hugo in his division of the books into chapters, he refined upon his invention as to the subdivision, and contrived that by verses: this being found to be a much more convenient method, it has been ever since followed. And thus, as the Jews borrowed the division of the books of the holy scriptures into chapters from the Christians, in like manner the Christians borrowed that of the chapters into verses from the Jews.

The order and division of the books of the Bible, as well of the Old as the New Testament, according to the disposition made by the council of Trent, by decree I. session iv, are as follow; where we are to observe, that those books to which the asterisks are prefixed, are rejected by the Protestants, as apocryphal. See APOCRYPHA.

- Genesis,
- Exodus,
- Leviticus,
- Numbers,
- Deuteronomy,
- Joshua,
- Judges and Ruth,
- 1 Samuel, or 1 Kings,
- 2 Samuel, or 2 Kings,
- 1 Kings, otherwise called iii. Kings,
- 2 Kings, otherwise called iv. Kings,
- 1 Chronicles,
- 2 Chronicles,
- 1 Esdras, (as the LXX and Vulgate call it), or the book of Ezra,
- 2 Esdras, or (as we have it) the book of Nehemiah.
- \* Tobit,
- \* Judith;
- Esther,
- Job,
- Psalms,
- Proverbs,
- Ecclesiastes,
- Song of Solomon,
- \* The book of Wisdom,
- \* Ecclesiasticus,
- Isaiah,
- Jeremiah and \* Baruch,
- Ezekiel,
- Daniel,
- Hosea,
- Joel,
- Amos,
- Obadiah,
- Nahum, which we place immediately after Micah, before Habakkuk.
- Jonah, which we place immediately after Obadiah.
- Micah,
- Habakkuk,
- Zephaniah,
- Haggai,
- Zechariah,
- Malachi,
- \* 1 Maccabees,
- \* Maccabees.

The books of the New Testament are,

- The Gospel of {
  - St Matthew,
  - St Mark,
  - St Luke,
  - St John,
- The acts of the Apostles,
  - the Romans,
  - the Corinthians I.
  - the Corinthians II.
  - the Galatians,
  - the Ephesians,
  - the Philippians,
  - the Colossians,
  - the Thessalonians I.
  - the Thessalonians II.
  - Timothy, I.
  - Timothy, II.
  - Titus,
  - Philemon,
  - the Hebrews.
- The Epistle of St Paul to
  - St James,
  - St Peter, I.
  - St Peter, II.
- The general Epistle of {
  - St John, I.
  - St John, II.
  - St John, III.
  - St Jude,

The Revelations of St John.

The apocryphal books of the Old Testament, according to the Romanists, are, the book of Enoch, (see Jude 14.) the third and fourth books of Esdras, the third and fourth books of Maccabees, the prayer of Manasseh, the Testament of the twelve Patriarchs, the Psalter of Solomon, and some other pieces of this nature.

The apocryphal books of the New Testament are the epistle of St Barnabas, the pretended epistle of St Paul to the Laodiceans, several spurious gospels, Acts of the Apostles, and Revelations; the book of Hermas, intitled the Shepherd; Jesus Christ's Letter to Abgarus, the epistles of St Paul to Seneca, and several other pieces of the like nature, as may be seen in the collection of the apocryphal writings of the New Testament made by Fabricius.

The books which are now lost, and cited in the Old Testament, are these, the book of the *Righteous*, or of Jasher, as our version of the Bible has it, (Josh. x. 13. and 2 Sam. i. 18.); the book of the wars of the Lord, (Numb. xxi. 14.); the annals of the kings of Israel, so often cited in the books of the Kings and Chronicles. The authors of these annals were the prophets, who lived in the kingdoms of Judah and Israel. We have likewise but a part of Solomon's three thousand proverbs, and his thousand and five songs, (1 Kings iv. 32.); and we have entirely lost what he wrote upon plants, animals, birds, fishes, and reptiles.

Ezra, in the opinion of most learned men, published the scriptures in the Chaldee character: For that language being grown wholly into use among the Jews, he thought proper to change the old Hebrew character for it, which hath since that time been retained only by the Samaritans, among whom it is preserved to this day.

Prideaux



Prideaux is of opinion that Ezra made additions in several parts of the Bible, where any thing appeared necessary for illustrating, connecting, or completing the work; in which he appears to have been assisted by the same spirit in which they were first written. Among such additions are to be reckoned the last chapter of Deuteronomy, wherein Moses seems to give an account of his own death and burial, and the succession of Joshua after him. To the same cause our learned author thinks are to be attributed many other interpolations in the Bible, which created difficulties and objections to the authenticity of the sacred text, no ways to be solved without allowing them. Ezra changed the names of several places which were grown obsolete, and instead of them put their new names, by which they were then called, in the text. Thus it is that Abraham is said to have pursued the kings who carried Lot away captive, as far as Dan; whereas that place in Moses's time was called Laish; the name Dan, being unknown till the Danites, long after the death of Moses, possessed themselves of it.

The Jewish canon of scripture was then settled by Ezra, yet not so but that several variations have been made in it. Malachi, for instance, could not be put in the Bible by him, since that prophet is allowed to have lived after Ezra; nor could Nehemiah be there, since mention is made, in that book, of Jaddus, as high-priest, and of Darius Codomannus, as king of Persia, who were at least an hundred years later than Ezra. It may be added, that in the first book of Chronicles, the genealogy of the sons of Zerubbabel is carried down for so many generations as must necessarily bring it to the time of Alexander, and consequently this book could not be in the canon in Ezra's days. It is probable, the two books of Chronicles, Ezra, Nehemiah, Esther, and Malachi, were adopted into the Bible in the time of Simon the Just, the last of the men of the great synagogue.

As the Jews were very backward in having any intercourse with strangers, it was a long time before their sacred books came to be known and read in other nations. Josephus ascribes the little that is said of the Jews by pagan writers to this, that the latter had no opportunity of being acquainted with their historians, for want of a translation of their books into the Greek language. Aristæus indeed pretends, that there was an imperfect version of the scriptures before the time of Demetrius Phalereus; and that Theopompus intending to insert a part of them in his verses, was deprived of his understanding; but of this there is no proof.

The Jews, upon their return from the Babylonish captivity, having brought with them their Chaldaic or Assyrian language, which from that time became their mother-tongue, gave birth to the Chaldee translations, or rather paraphrases of the Bible, called *Targum*. See TARGUM.

*Greek Bible.* It is a matter of dispute among authors whether there was a Greek version of the Old Testament more ancient than the Septuagint. See SEPTUAGINT.

Before our Saviour's time, there was no other Greek version of the Old Testament, besides that which went under the name of the Septuagint: But after the establishment of Christianity, some authors undertook new translations, under pretence of making them more con-

formable to the Hebrew text. The first who performed this design was the Jewish profelyte Aquila, who of the city of Synope in Pontus, disciple to Rabbi Akiba, who put it in execution the twelfth year of the emperor Adrian, A. D. 128. St Epiphanius pretends, that being excommunicated after his conversion, for addicting himself to judicial astrology, he sat about this version out of hatred to the Christians, and with a wicked design of corrupting the passages of the prophets relating to Jesus Christ. St Jerom says, his version is made word for word, and with too scrupulous a nicety.

The second Greek version after the Septuagint is that of Symmachus, a Samaritan by birth, who first turned Jew, then Christian, and at last Ebionite. He composed it, according to Epiphanius, in the reign of the emperor Severus. His version was more free than the rest; for he applied himself chiefly to the sense, without translating word for word; therefore his version comes nearer the Septuagint than that of Aquila. The third Greek version is that of Theodotion of Ephesus. It is said he was a disciple of Marcion, and that, having had some difference with those of his sect, he turned Jew. The version of this author was the best of the three, because he kept a just medium between Aquila and Symmachus, not confining himself so servilely to the letter as the first did, nor wandering so far from it as the second did.

There were, besides these, three other Greek versions, whose authors are unknown.

*Syriac Bible.* The Syrians have in their language a version of the Old Testament, which they pretend to be of great antiquity. A great part of it, they say, was made in Solomon's time, and the rest in the time of Abgarus king of Edessa. They relate, that Hiram king of Tyre desired Solomon to communicate the use of letters and writing to the Syrians, and to get translated for them the sacred books of the Hebrews; which Solomon complied with, and sent them the Pentateuch, Joshua, Judges, Ruth, Samuel, Psalms, Proverbs, Ecclesiastes, Solomon's Song, and Job, which were the only books then extant; the remaining books of scripture, they add, were translated into Syriac after the death of Christ, by the care of Abgarus king of Edessa. But this account is looked upon as fabulous. It is true, the Syriac version which we have now must be very ancient, since it is often cited by the fathers. Dr Prideaux is of opinion, it was made within the first century; that the author of it was some Christian of the Jewish nation; and that it is the best translation of the Old Testament. This version is not always agreeable to the original; but in some places is more conformable to the Samaritan Pentateuch, and in some to the version of the Septuagint. In the Psalms, the translator has taken the liberty to leave out the ancient titles and inscriptions of each psalm, instead of which he gives an abstract of the contents of each psalm.

*Latin Bible.* It is past dispute, that the Latin churches had, even in the first ages, a translation of the Bible in their language, which being the vulgar language, and consequently understood by every one, occasioned a vast number of Latin versions. Among all these, there was one which was generally received, and called by St Jerom the vulgar, or common translation. St Au-

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fin gives this version the name of the Italic, and prefers it to all the rest: But we reserve a distinct article for this version. See *VULGATE*.

St Jerom undertook to revise and correct the Latin version of the Bible; but, having afterwards attained to a more perfect knowledge of the Hebrew language, he set about a new translation of some books of the Old Testament from the Hebrew; and continuing, at the solicitation of his friends, to translate the rest, he at last perfected an entire new version of all the books contained in the Hebrew canon. In his translation, he followed, as nearly as he could, the version of the Septuagint, and retained the very expressions of the ancient vulgar Latin, as far as was consistent with purity of style and true Latinity. This translation was so highly applauded by the Christian church, that some authors have pretended it was brought to perfection by the inspiration of the Holy Ghost. But St Augustine looked upon the author to be so well skilled in the Hebrew language, as to be able to undertake, and bring to perfection such a work by the strength of his own abilities. St Jerom's version was soon received in many churches; and in the sixth century it became as general, and in as great esteem, as the ancient Vulgate.

It was not till the sixteenth century that any new Latin translations were made of the Bible from the Hebrew text. Sanctes Pagninus, a Dominican monk, was the first who undertook a new version of the books of scripture from the modern Hebrew text. His design was encouraged by pope Leo X.; and his version made its first appearance at Lyons in the year 1527. It adheres too scrupulously to the words of the text, which makes it obscure, and favour of barbarity in many places. He is likewise often misled as to the sense, having affected too much to follow the explications of the Jewish Rabbins. It is however a very useful work, and very proper to explain the literal sense of the Hebrew text. Arias Montanus, when he compiled the edition of the *Biblia Polyglotta*, revised this translation of Pagninus.

Cardinal Cajetan, though not versed in the Hebrew, undertook a translation of some parts of the Bible by the assistance of two persons well skilled in that language, the one a Jew, the other a Christian. After him Isidore Clarius, a monk of Mount Cassin, set himself to reform the vulgar version of the Bible after the Hebrew text; in the doing of which he pretends to have corrected above eight thousand passages of the Bible. Besides these translations, made by catholic authors, there are some likewise performed by protestant translators; the first of whom was Sebastian Munster. His version is more intelligible, and in much better Latin, than that of Pagninus. Huetius bestows on him the character of a translator well versed in the Hebrew, and whose style is very exact and conformable to the original. The translation of Leo Juda, a Zuinglian, printed at Zurich in 1543, and afterwards by Robert Stephens in 1545, is written in a more elegant style than that of Munster; but he often departs from the literal meaning of the Hebrew text for the sake of an elegant Latin expression. However, in this he has not taken so great a liberty as Sebastian Castalio, who undertook to give the world an elegant Latin version of

the Bible: But there are critics who censure him for departing from the noble simplicity and natural grandeur of the original, and deviating into an affected effeminate style, overcharged with false rhetoric, and not always true Latinity. The version of Junius and Tremellius, has much more of the true natural simplicity: The chief Hebraisms are preserved in it, and the whole is strictly conformable to the Hebrew text. We must not forget the version of Theodore Beza, a protestant divine of Geneva, in the sixteenth century. Sebastian Castalio found fault with this version, and Beza wrote an apology for it about the year 1564.

*Arabic BIBLE.* The Arabic versions of the Bible are of two sorts; the one done by Christians, the other by Jews. There is one of the Old Testament, whose author is supposed to be Saadiah Gaon, a Jew of Babylon, who wrote the same about the year of Christ 900. Of this whole work the Pentateuch alone is printed. The Jews have another Arabic version in Hebrew characters, which Erpenius published in Arabic characters at Leyden in the year 1622. Among the Arabic translations done by Christians, there is one printed in the polyglots of Paris and London; but both the author, and the time when it was written, are unknown. It must have been made since the publication of the Koran, because the author, in many places, has evidently followed it. In this version the Pentateuch is translated from the Hebrew text; Job, from the Syriac; and the rest from the Septuagint, and two other versions of the Pentateuch, the manuscripts of which are in the Bodleian library. There are also some Arabic translations of the Psalms; one printed at Genoa in 1516, the other at Rome in 1619: And there is a manuscript version of the prophets in this language preserved in the Bodleian library.

The gospel being preached in all nations, there is no doubt, but that the Bible, which is the foundation of the Christian religion, was translated into the respective languages of each nation. St Chrysostom and Theodoret both testify, that the books of the Old and New Testament had been translated into the Syriac, Egyptian, Indian, Persian, Armenian, Æthiopic, Scythian, and Samaritan languages. Socrates and Sozomen tell us, that Ulphilas bishop of the Goths, who lived about the middle of the fourth century, had translated the holy scriptures into the Gothic language; and pope John VIII. gave his approbation to the version of the holy scriptures made into the Slavonian.

*Æthiopic BIBLE.* The Æthiopic version of the Old Testament is made immediately from the Greek text of the Septuagint; and there is a very plain agreement between this translation and the Alexandrian manuscript: The order of the chapters, the inscriptions of the Psalms, and every thing else being exactly alike. The Æthiopians attribute this version to Frumentius, the apostle of Æthiopia, sent thither by Athanasius bishop of Alexandria.

*Coptic or Egyptian BIBLE.* The Coptic or Egyptian translation is likewise made from the Greek of the Septuagint, in which the Egyptian translator so punctually followed the Greek text, that he refused to make use of the labours of Origen and others, who had been at the pains

pains to compare the Greek version with the Hebrew text. We are quite in the dark as to the author and the time of this version, but probably it is very ancient, since we cannot suppose the Egyptian church was long without a translation of the scriptures in their mother tongue.

*Persian and Turkish BIBLE.* There are several versions of the Bible in the Persian language, most of which are in manuscript. There is a translation of the Psalms by one father John, a Carmelite; and another of the same book done from the Latin by the Jesuits. Walton, in the London Polyglott, has published the Gospels, translated by one Simon the son of Joseph, a Christian of Persia, who lived in the year 1341. We have likewise some manuscript translations of the Bible in the Turkish language, particularly a version of the New Testament printed at London in the year 1666.

*Armenian and Georgian BIBLE.* The Armenians have an old translation of the scriptures in their language, taken from the Greek of the Septuagint. Three learned Armenians were employed about it, in the time of the emperor Arcadius, viz. Moses surnamed the Grammarian, David the Philosopher, and Mampræus. The Armenians, in 1666, procured an edition of the Bible in their language to be made at Amsterdam, under the direction of an Armenian bishop. Another was printed at Antwerp in 1670, by the procurement of Theodorus Patrusus, and the New Testament separately in 1668.

The Georgians have likewise a translation of the Bible in the old Georgian language: But as this language is known only to a very few persons, and the people of the country are extremely ignorant, there is scarce any one who either reads or understands this version.

Whilst the Roman empire subsisted in Europe, the reading of the scriptures in the Latin tongue, which was the universal language of that empire, prevailed every where. But since the face of affairs in Europe has been changed, and so many different monarchies erected upon the ruins of the Roman empire, the Latin tongue has by degrees grown into disuse; whence has arisen a necessity of translating the Bible into the respective languages of each people; and this has produced as many different versions of the scriptures in the modern languages, as there are different nations professing the Christian religion. Hence we meet with French, Italian, Spanish, German, Flemish, Danish, Sclavonian, Polish, Bohemian, and Russian or Muscovite Bibles; besides the Anglo-Saxon and modern English and Irish Bibles.

*French BIBLE.* The oldest French Bible we hear of is the version of Peter de Vaux, chief of the Waldenses, who lived about the year 1160. Raoul de Presle translated the Bible into French in the reign of Charles V. king of France, about the year 1380. Besides these, there are several old French translations of particular parts of the scripture. The doctors of Louvain published the Bible in French at Louvain, by order of the emperor Charles V. in 1550. There is a version by Isaac le Maître de Sacy, published in 1672, with explanations of the literal and spiritual meaning of the text, which was received with wonderful applause, and has been often reprinted. As to the New Testaments in

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French, which have been printed separately, one of the most remarkable is that of F. Amelotte of the oratory, composed by the direction of some French prelates, and printed with annotations in the year 1666, 1667, and 1670. The author pretends he had been at the pains to search all the libraries in Europe, and collate the oldest manuscripts. But, in examining his work, it appears that he has produced no considerable various readings; which had not before been taken notice of either in the London Polyglott or elsewhere. The New Testament of Mons printed in 1665, with the archbishop of Cambray's permission, and the king of Spain's licence, made a great noise in the world. It was condemned by pope Clement IX. in 1668, and by pope Innocent XI. in 1679, and in several bishoprics of France at several times. The New Testament published at Trevoux in 1702, by M. Simon, with literal and critical annotations upon difficult passages, was condemned by the bishops of Paris and Meaux in 1702. F. Bohours, a Jesuit, with the assistance of F. F. Michael Tellier, and Peter Bernier, Jesuits likewise, published a translation of the New Testament in 1697: But this translation is, for the most part, harsh and obscure, which was owing to the author's keeping too strictly to the Latin text from which he translated.

There are likewise French translations published by Protestant authors; one by Robert Peter Olivetan, printed at Geneva in 1535, and since often reprinted with the corrections of John Calvin and others; another by Sebastian Castalio, remarkable for particular ways of expression never used by good judges of the language. John Diodati likewise published a French Bible at Geneva in 1644; but some find fault with his method, in that he rather paraphrases the text than translates it. Faber Stapalensis translated the New Testament into French, which was revised and accommodated to the use of the reformed churches in Piedmont, and printed in 1534. Lastly, M. John Le Clerc published a New Testament in French at Amsterdam in 1703, with annotations taken chiefly from Grotius and Hammond; but the use of this version was prohibited in Holland by order of the States-General, as tending to revive the errors of Sabellius and Socinus.

*Italian BIBLE.* The first Italian Bible published by the Romanists, is that of Nicolas Malerme, a Benedictine monk, printed at Venice in 1471. It was translated from the Vulgate. The version of Anthony Brucioli, published at Venice in 1532, was prohibited by the council of Trent. The Calvinists likewise have their Italian Bibles. There is one of John Diodati in 1607 and 1641, and another of Maximus Theophilus in 1551, dedicated to Francis de Medicis duke of Tuscany. The Jews of Italy have no entire version of the Bible in Italian; the inquisition constantly refusing to allow them the liberty of printing one.

*Spanish BIBLE.* The first Spanish Bible that we hear of, is that mentioned by Cyprian de Valera, which he says was published about the year 1500. The Epistles and Gospels were published in that language by Ambrose de Montefin in 1512; the whole Bible by Cassiodore de Reyna, a Calvinist, in 1569; and the New Testament,

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dedicated

dedicated to the emperor Charles V. by Francis Enzinas, otherwise called Driander, in 1543. The first Bible which was printed in Spanish for the use of the Jews, was that printed at Ferrara in 1553, in Gothic characters, and dedicated to Hercules d'Est duke of Ferrara. This version is very ancient, and was probably in use among the Jews of Spain before Ferdinand and Isabella expelled them out of their dominions in 1492.

*German Bible.* The first and most ancient translation of the Bible in the German language, is that of Ulphilas bishop of the Goths, about the year 360. This bishop left out the books of Kings, which treat chiefly of war, lest it should too much encourage the martial humour of the Goths. An imperfect manuscript of this version was found in the abbey of Verden near Cologne, written in letters of silver, for which reason it is called *Codex Argenteus*; and it was published by Francis Junius in 1665. The oldest German printed Bible extant, is that of Nuremberg, printed in 1447; but who the author of it was, is uncertain. John Emzer, chaplain to George duke of Saxony, published a version of the New Testament in opposition to Luther. There is a German Bible of John Eckius in 1537, with Emzer's New Testament added to it; and one by Ulebergius of Westphalia, procured by Ferdinand duke of Bavaria, and printed in 1630. Martin Luther, having employed eleven years in translating the Old and New Testament, published the Pentateuch in 1522, the historical books and the Psalms in 1524, the books of Solomon in 1527, Isaiah in 1529, the Prophets in 1531, and the other books in 1530: He published the New Testament in 1522. The learned agree, that his language is pure, and the version clear, and free from intricacies: It was revised by several persons of quality, who were masters of all the delicacies of the German language. The German Bibles which have been printed in Saxony, Switzerland, and elsewhere, are for the most part the same as that of Luther, with very little variation. In 1604, John Pifcator published a version of the Bible in German, taken from that of Junius and Tremellius: But his turn of expression is purely Latin, and not at all agreeable to the genius of the German language: The Anabaptists have a German Bible printed at Worms in 1529. John Crellius published his version of the New Testament at Racovia in 1630; and Felbinger his, at Amsterdam, in 1660.

*Flemish Bible.* The Flemish Bibles of the Romanists are very numerous, and for the most part have no author's name prefixed to them, till that of Nicolas Vinck, printed at Lovain in 1548. The Flemish versions made use of by the Calvinists till the year 1637, were copied principally from that of Luther. But the synod of Dort having in 1618 appointed a new translation of the Bible into Flemish, deputies were named for the work, which was not finished till the year 1637.

*Danish Bible.* The first Danish Bible was published by Peter Palladius, Olaus Chrysoftom, John Synningius, and John Maccabæus, in 1550, in which they followed Luther's first German version. There are two other versions, the one by John Paul Refenius bishop of Zealand, in 1605; the other, being the New Testament only, by John Michel, in 1524.

*Swedish Bible.* In 1534 Olaus and Laurence published a Swedish Bible from the German version of Martin Luther. It was revised in 1617, by order of king Gustavus Adolphus, and was afterwards almost universally followed.

*Bohemian, Polish, Russian or Muscovite, and Sclavonian Bibles.* The Bohemians have a Bible translated by eight of their doctors, whom they had sent to the schools of Wittemberg and Basil, on purpose to study the original languages. It was printed in Moravia in the year 1539. The first Polish version of the Bible, it is said, was that composed by Hadewich wife of Jagellon, duke of Lithuania, who embraced Christianity in the year 1390. In 1599, there was a Polish translation of the Bible published at Cracow, which was the work of several Divines of that nation, and in which James Wiecek, a Jesuit, had a principal share. The Protestants, in 1596, published a Polish Bible from Luther's German version, and dedicated it to Uladislavus IV. king of Poland. The Russians or Muscovites published the Bible in their language in 1581. It was translated from the Greek by St Cyril, the apostle of the Sclavonians; but this old version being too obscure, Ernest Gliik, who had been carried prisoner to Moscow after the taking of Narva, undertook a new translation of the Bible in the Sclavonian; who dying in 1705, the Czar Peter appointed some particular divines to finish the translation: But whether it was ever printed, we cannot say.

*English-Saxon, and modern English Bibles.* If we inquire into the versions of the Bible of our own country, we shall find that Adelm bishop of Sherburn, who lived in 709, made an English-Saxon version of the Psalms; and that Eadfrid, or Ecbert, bishop of Lindisferne, who lived about the year 730, translated several of the books of scripture into the same language. It is said likewise, that venerable Bede, who died in 785, translated the whole Bible into Saxon. But Cuthbert, Bede's disciple, in the enumeration of his master's works, speaks only of his translation of the Gospel; and says nothing of the rest of the Bible. Some pretend, that king Alfred, who lived in 890, translated a great part of the scriptures. We find an old version in the Anglo-Saxon of several books of the Bible, made by Elfric abbot of Malmesbury: It was published at Oxford, in 1699. There is an old Anglo-Saxon version of the four Gospels, published by Matthew Parker, archbishop of Canterbury, in 1571, the author whereof is unknown. Dr Mill observes, that this version was made from a Latin copy of the old Vulgate.

As to the English versions of the Bible, the most ancient is that of John de Trevisa, a secular priest, who translated the Old and New Testament into English, at the request of Thomas lord Berkley: He lived in the reign of Richard II. and finished his translation in the year 1357. The second author, who undertook this work, was the famous Wickliff, who lived in the reigns of Edward III. and Richard II. The manuscript of his version is in several libraries in England. In the year 1534, an English version of the Bible, done partly by William Tindal, and partly by Miles Coverdale, was brought

brought into England from Antwerp. The bishops found great fault with this translation; upon which a motion was made in convocation for an English translation of the Bible to be set up in all churches. This motion, though opposed by bishop Gardiner and his party, succeeded at last. The king gave orders for setting about it with all possible haste, and within three years the impression of it was finished. Cromwell procured a general warrant from the king, allowing all his subjects to read it; for which Cranmer wrote his thanks to Cromwell, 'rejoicing to see the work of reformation now risen in England, since the word of God did now shine over it all without a cloud.' Cromwell likewise gave out injunctions, requiring the clergy to set up Bibles in all their churches, and to encourage the people to read them. In 1542, an act passed for restraining the use of the Bible. The preamble sets forth, that 'many seditious and ignorant people had abused the liberty granted them for reading the Bible; and that great diversity of opinions, animosities, tumults, and schisms had been occasioned by perverting the sense of the scripture. To retrieve the mischiefs arising from hence, it is enacted, that a certain form of orthodox doctrine be set forth, as a standard of belief; and that Tindal's *falsa translation* of the Old and New Testament be suppressed, and forbidden to be read in any of the king's dominions.' In the reign of Edward VI. Fuller mentions another translation of the Bible, printed in two editions; the first in 1549, the other in 1551, but neither of them divided into verses.

In the reign of queen Elizabeth came out the Bishops Bible, so called, because several of that order were concerned in that version. The work was divided into several parcels, and assigned to men of learning and character. Most of the divisions are marked with great initial letters, signifying either the name or the titles of the persons employed. Archbishop Parker had the principal direction of this affair; he revised the performance, and perhaps put the finishing hand to it. He likewise employed several critics in the Hebrew and Greek languages, to review the old translation, and compare it with the original.

The last English Bible is that called King James's Bible, which proceeded from the Hampton-court conference in 1603, where many exceptions being made to the Bishops Bible, king James gave orders for a new one, not, as the preface expresses it, for a translation altogether new, nor yet to make of a bad one a good one, but to make a good one better; or of many good ones, one best. Fifty-four learned persons were appointed for this office by the king, as appears by his letter to the archbishop, dated in 1604, which being three years before the translation was entered upon, it is probable seven of them were either dead, or had declined the task, since Fuller's list of the translators makes but forty-seven, who being ranged under six divisions, entered on their province in 1607. It was published in 1610, with a dedication to king James, and a learned preface, and is commonly called king James's Bible. After this all other versions dropped, and fell into disuse, except the Epistles and Gospels in the Common-prayer book, which were

still continued, according to the bishops translation, till the alteration of the Liturgy in 1661, and the Psalms and hymns, which are to this day continued as in the old version.

The judicious Selden, in his Table-Talk, speaking of the Bible, says, 'The English translation of the Bible is the best translation in the world, and renders the sense of the original best, taking in for the English translation the bishops Bible, as well as king James's. The translators in king James's time took an excellent way. That part of the Bible was given to him who was most excellent in such a tongue, (as the Apocrypha to Andrew Downs) and then they met together, and one read the translation, the rest holding in their hands some Bible either of the learned tongues, or French, Spanish, Italian, &c. If they found any fault, they spoke; if not, he read on.'

King James's Bible is that now read by authority in all the churches in England.

*Irish Bible.* Towards the middle of the sixteenth century, Bedell, bishop of Kilmore, set on foot a translation of the Old Testament into the Irish language; the New Testament and the Liturgy having been before translated into that language. The bishop appointed one King to execute this work, who, not understanding the oriental languages, was obliged to translate it from the English. This work was received by Bedell, who, after having compared the Irish translation with the English, compared the latter with the Hebrew, the LXX. and the Italian version of Diodati. When this work was finished, the bishop would have been himself at the charge of the impression, but his design was stopped upon advice given to the lord-lieutenant and the archbishop of Canterbury, that it would prove a shameful thing for a nation to publish a Bible translated by such a despicable hand as King. However, the manuscript was not lost, for it went to press in the year 1685.

**BIBLIOTHECA**, in its original and proper sense, denotes a library, or place for depositing books.

**BIBLIOTHECA**, in matters of literature, denotes a treatise, giving an account of all the writers on a certain subject: Thus, we have bibliothecas of theology, law, philosophy, &c.

There are likewise universal bibliothecas; which treat indifferently of all kinds of books; also select bibliothecas, which give an account of none but authors of reputation.

**BIBLISTS**, so the Roman-catholics call those Christians that make scripture the sole rule of faith; in which sense, all protestants either are, or ought to be, biblists.

**BIBRACH**, an imperial city of Swabia in Germany, about twenty miles south-west of Ulm; E. long. 9° 30', and N. lat. 48° 12'.

**BICANER**, a city of Asia, in the country of the Mogul, upon the Ganges. It is the capital of the province of Bacar; E. long. 87° 20', N. lat. 28° 40'.

**BICAUDA**, in ichthyology, a name given to the xiphias, or sword-fish. See **XIPHIAS**.

**BICE**,

**BICE**, or **BISE**, among painters, a blue colour prepared from the lapis armenus.

Bice bears the best body of all bright blues used in common work, as house-painting, &c. but it is the palest in colour. It works indifferently well, but inclines a little to sandy, and therefore requires good grinding. Next to ultramarine, which is too dear to be used in common work, it lies best near the eye of all other blues.

**BICEPS**, in anatomy, the name of several muscles: As the biceps humeri, or cubiti, biceps tibiz, &c.

**BICHET**, a quantity, or measure of corn, which differs according to the places where it is used. The bichet is not a wooden measure, as the minot at Paris, or the bushel at London, but is compounded of several certain measures. It is used in many parts of France, &c.

**BICHET**, a certain quantity of land, namely, as much as may be sown by a bichet of corn.

**BICKERN**, the beak-iron of an anvil. See the article **ANVIL**.

**BICLINIUM**, in Roman antiquity, a chamber with two beds in it; or when two beds only were round a table. See **TABLE**.

**BICORNIS**, in anatomy, a name for the os hyoides. See **HYOIDES**.

**BICORNIS musculus**, a name for the extensor carpi radialis.

**BIDDING** of the banns, the same with what is otherwise called *asking*. See **MARRIAGE**.

**BIDDING**, in a commercial sense, the offering a sum of money, or a certain price, for any ware or merchandize; and when any thing is sold by auction, a person who has a mind to have it, must offer something more for it than the person who bade last.

**BIDDER**, he that bids money for any merchandize that is selling by auction: The best, or last bidder, is he who offers most money for it. See **SALE**.

**BIDENS**, in botany, a genus of the syngenesia polygamia æqualis class. The receptacle is paleaceous; the pappus has erect scabrous awns; and the calix is imbricated. There are thirteen species, only three of which, *viz.* the tripartita or trifid water-hemp agrimony, the cornua or whole-leaved water-hemp agrimony, and the minima or least water-hemp agrimony, are natives of Britain. The leaves of the bidens are recommended for strengthening the tone of the viscera, and as an aperient; and said to have excellent effects in the dropsy, jaundice, cachexies, and scorbutic disorders.

**BIDENTAL**, in Roman antiquity, a place blasted with lightning, which was immediately consecrated by an haruspex, with the sacrifice of a bidens. This place was afterwards accounted sacred, and it was unlawful to enter it, or to tread upon it; for which reason it was commonly surrounded with a ditch, wall, hedge, ropes, &c. See the next article.

**BIDENTALES**, in Roman antiquity, priests instituted to perform certain ceremonies and expiations when thunder fell on any place. Their principal office was the sacrificing a sheep of two years old, which, in La-

tin, is called *bidens*; from whence the place struck with thunder got the name of *bidental*.

**BIDON**, a liquid measure, containing about five pints of Paris, that is, about five quarts English wine-measure. It is seldom used but among ships crews.

**BIEL**, a town of the canton of Bern in Switzerland, situated at the north-end of a lake to which it gives name, about fifteen miles north-west of the city of Bern, in 7° E. long. 47° 15' N. lat.

**BIELSKI**, a town of Polachia in Poland, about sixty-two miles south of Grodno; E. long. 24°, and N. lat. 53°.

**BIELSKI**, or **BIHEL**, is also a town of Smolensko, in Russia; E. long. 35°, and N. lat. 56° 40'.

**BIER**, a wooden machine for carrying the bodies of the dead to be buried. See **BURIAL**.

**BIENNE**, in geography. See **BIEL**.

**BIGA**, in antiquity, a chariot drawn by two horses abreast. Chariot-races, with two horses, were introduced into the Olympic games in the 93d Olympiad: But the invention was much more ancient, as we find that the heroes in the Iliad fight from chariots of that kind.

**BIGAMY**, the possession of two husbands or two wives at the same time. See **SCOTS LAW**, *the Crimes*.

**BIGEN**, the name of a kingdom and city in Japon, in the island Nippon.

**BIGGLESWADE**, a market-town in Bedfordshire, situated on the river Ivel, about eight miles south-east of Bedford; W. long. 20', N. lat. 52° 5'.

**BIGHT**, among seamen, denotes one roll, or round, of a cable or rope, when coiled up.

**BIGNESS**, or **MAGNITUDE**. See **MAGNITUDE**.

**BIGNONIA**, in botany, a genus of the didynamia angiospermia class. The calix consists of five segments, and is shaped like a cup; the faux of the corolla is bell-shaped, and divided into five segments; the pod has two cells, and the seeds are membranaceous, and alated. The species are seventeen, all natives of America and the Indies.

**BIGOREE**, the south division of the province of Gafcony, in France.

**BIGOT**, a person foolishly obstinate and perversely wedded to any opinion, but particularly an opinion of a religious nature.

**BILANDER**, a small flat-bottomed vessel, with only one large mast and sail, and its deck raised half a foot above the plat-board.

**BILATERAL**, in a general sense, denotes something with two sides. Hence,

**BILATERAL COGNATION**, is kinship both by the father and mother side.

**BILAWS**. See **BY-LAWS**.

**BILBOA**, the capital of the province of Biscay, in Spain, situated near the mouth of the river Ibaicabal, which, falling into the sea a little below it, forms a good harbour; in 3° W. long. and 43° 30' N. lat.

**BILBOWS**, a punishment at sea, answering to the stocks at land. The offender is laid in irons, or stocks, which are more or less ponderous according to the quality of the offence of which he is guilty.

**BIL**

**BILDESTON**, a market-town of Suffolk, about ten miles south-east of Bury, E. long 40', and N. lat. 52° 20'.

**BILDGE** of a ship, the bottom of her floor, or the breadth of the place the ship rests on when she is aground. Therefore, bildge-water is that which lies on her floor, and cannot go to the well of the pump: And bildge-pumps, or burr-pumps, are those that carry off the bildge-water. They likewise say the ship is bildged, when she has some of her timber struck off on a rock or anchor, and springs a leak.

**BILE**, a yellow, bitter juice, separated from the blood in the liver, collected in the porus bilarius and gall-bladder, and thence discharged by the common duct into the duodenum.

The bile is properly of two kinds, and is distinguished by the names of *cystic* and *hepatic*. The hepatic bile is thin, almost insipid, and scarce coloured; the cystic bile is thicker, more coloured, and very bitter. See **ANATOMY**, p. 265.

**BILEDULGERID**, one of the divisions of Africa, having Barbary on the north, and Zaara or the Desert on the south.

**BILEVEST**, a town of Westphalia, in Germany, about seven miles south-east of Ravensburg, E. long. 8° 15', N. lat. 52°. It is subject to the king of Prussia.

**BILGE**. See **BILDGE**.

**BILIARY ducts**. See **ANATOMY**, p. 265.

**BILIMBI**, in botany, a synonyme of the averrhoa. See **AVERRHOA**.

**BILINGUIS**, in a general sense, signifies one that speaks two languages; but in law, is used for a jury that passes in any case between an Englishman and a foreigner, whereof part ought to be English, and part strangers.

**BILOUS**, in general, denotes something belonging to, or partaking of, the nature of bile. Hence,

**BILIOUS fevers** are those occasioned by the over-copiousness, or bad qualities of the bile. See **MEDICINE**, *Of fevers*.

**BILIOUS colic**. See **MEDICINE**, *Of colics*.

**BILL**, an instrument made of iron, edged in the form of a crescent, and adapted to a handle. It is used by plumbers, to perform several parts of their work; by basket-makers, to cut the largest pieces of chestnut-trees and other wood; and by gardeners, to prune trees. When short, it is called a *hand-bill*, and when long, a *hedge-bill*.

**BILL**, in Scots law, has two general significations: Every summary application in writing, by way of petition, to the court of session, is called a *bill*. But the word more commonly denotes a short obligation or mandate, by which one person obliges himself to pay a sum of money to another, or his order, against a certain time; or by which one person draws upon another for a sum payable to a third person: By this last kind of bill, money-matters are commonly transacted betwixt the inhabitants of different countries, and is called a *bill of exchange*: When the parties concerned live in Scotland, it is termed an *inland bill*. As to the solemnities of bills, methods of negotiating them, their le-

gal privileges, &c. See **SCOTS LAW**, tit. *Obligations by word and writ*.

**BILL** signifies also a paper, either written or printed, in very large characters, which is posted up in some open and public place, to give notice of the sale of any merchandize, or ship, or of the failing of any vessel into foreign parts.

**BILL in trade**, both wholesale and retail, as also among workmen, signifies an account of merchandizes or goods delivered to a person, or of work done for one.

**Settled BILL**, a bill, at the bottom of which they to whom the goods are delivered acknowledge that they have received them; that they are satisfied with the price, and promise to pay it.

**BILL of credit**, that which a merchant or banker gives to a person whom he can trust, empowering him to receive money from his correspondents in foreign countries.

**BILL of entry**, an account of the goods entered at the custom-house, both inwards and outwards. In this bill must be expressed, the merchant exporting or importing; the quantity of merchandize, and the divers species thereof; and whither transported, or from whence.

**BILL of lading**, an acknowledgment signed by the master of a ship, and given to a merchant, &c. containing an account of the goods which the master has received on board from that merchant, &c. with a promise to deliver them at an intended place for a certain salary. Each bill of lading must be treble, one for the merchant who loads the goods, another to be sent to the person to whom they are consigned, and the third to remain in the hands of the master of the ship. It must be observed, however, that a bill of lading is used only when the goods, sent on board a ship, are but part of the cargo: For when a merchant loads a whole vessel for his own personal account, the deed passed between him and the master of the ship is called *charter-party*. See **CHARTER-party**.

**BILL of parcels**, an account given by the feller to the buyer, containing the particulars of all the sorts and prices of the goods bought.

**BILL of sale**, is when a person wanting a sum of money, delivers goods as a security to the lender, to whom he gives this bill, empowering him to sell the goods, in case the sum borrowed is not repaid, with interest, at the appointed time.

**BILL of store**, a licence granted at the custom-house to merchants, by which they have liberty to carry, custom-free, all such stores and provisions as they may have occasion for during their voyage.

**BILL of sufferance**, a licence granted to a merchant, at the custom-house, suffering him to trade from one English port to another, without paying custom.

**Bank-BILL**, a private instrument whereby private persons become intitled to a part in the bank-stock. See **BANK**.

**BILL** denotes also a declaration in writing, expressing either some wrong the complainant has suffered by the defendant, or else a fault that the party complained of has committed against some law or statute of the realm.

This bill is sometimes exhibited to justices at the general assizes, by way of indictment, or referred to others having jurisdiction; but more especially is addressed to the lord-chancellor, for inconfessionable wrongs done. It contains the thing or fact complained of, the damage sustained, and a petition or process against the defendant for redress; and is used both in criminal and civil cases. In a criminal case, the words

**BILLA vera** are indorsed by the grand jury upon a presentment, thereby signifying, that they find the same made with probable evidence, and on that account worthy of farther consideration.

**BILL in parliament**, a paper containing propositions offered to the houses to be passed by them, and then presented to the king to pass into a law.

**BILL of attainder**. See **ATTAINDER**.

**BILL of appeal**. See **APPEAL**.

**BILL of mortality**. See **MORTALITY**.

**BILLARD**, a name given, in some parts of the kingdom, to the young fish of the gadus-kind. See **GADUS**.

**BILLERCA**, a market-town of Essex, about twenty miles east of London, in E. long. 20', and N. lat. 51° 35'.

**BILLET**, in heraldry, a bearing in form of a long square. They are supposed to represent pieces of cloth of gold or silver; but Guillim thinks they represent a letter sealed up; and other authors take them for bricks.

Billeté signifies that the escutcheon is all over-strewed with billets, the number not ascertained. See Plate LI. fig. 15

**BILLET-wood**, small wood for fuel, cut three foot and four inches long, and seven inches and a half in compass; the assize of which is to be inquired of by justices.

**BILLETING**, in military affairs, is the quartering of soldiers in the houses of a town or village. And, among fox-hunters, it signifies the ordure and dung of a fox.

**BILLIARDS**, an ingenious kind of game, played on a rectangular table, covered with green cloth, and placed exactly level, with little ivory balls, which are driven by crooked sticks, made on purpose, into hazards or holes, on the edge and corners of the table, according to certain rules of the game.

**BILLINGHAM**, a market-town of Northumberland, about twenty-five miles north-west of Newcastle, in W. long. 1° 40', and N. lat. 55° 20'.

**BILLITON**, an island in the E. Indian ocean, lying south-west of Bornea, in 1° 12' S. lat.

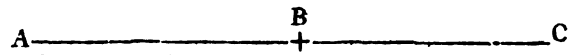
**BILLON**, in the history of coins, a composition of precious and base metals, where the latter predominate. Wherefore gold under twelve carats fine, is called billon of gold; and silver under six penny-weight, billon of silver. So little attention was paid formerly to the purity of gold and silver, that the term billon of gold was applied only to that which was under twenty-one carats; and billon of silver to that which was lower than ten penny-weight.

**BILLON**, in geography, a town of the Lower Auvergne, in the Lyonois in France, about ten miles south-east of Clermont; E. long. 3° 25', and N. lat. 45° 40'.

**BILSDON**, a market-town of Leicestershire, about seven miles south-east of Leicester; W. long. 50', and N. lat. 52° 40'.

**BILSEN**, a town of Germany, about six miles west of Maestricht; E. long. 5° 30', and N. lat. 51°.

**BIMEDIAL**, in mathematics. If two medial lines, as AB and BC, commensurable only in power, containing a rational rectangle, are compounded, the whole line AC will be irrational, and is called a first bimedral line.



See Euclid. lib. X. prop. 38.

**BIMINI**, one of the Lucaya-islands, in N. America, to the south of the Bahama-islands.

**BIMLIPATAN**, a port-town of Golconda in India, where the Dutch have a factory. It is situated on the west side of the bay of Bengal, in 83° E. long. and 18° N. lat.

**BINARY arithmetick**, that wherein unity, or 1 and 0 are only used.

This was the invention of M. Leibnitz, who shews it to be very expeditious in discovering the properties of numbers, and in constructing tables: and Mr Dangeourt, in the history of the royal academy of sciences, gives a specimen of it concerning arithmetical progressionals; where he shews, that because, in binary arithmetick, only two characters are used, therefore the laws of progression may be more easily discovered by it than by common arithmetick.

All the characters used in binary arithmetick are 0 and 1, and the cipher multiplies every thing by 2, as in the common arithmetic by 10. Thus 1 is one; 10, two; 11, three; 100, four; 101, five; 110, six; 111, seven; 1000, eight; 1001, nine; 1010, ten; which is built on the same principles with common arithmetick.

The author, however, does not recommend this method for common use, because of the great number of figures required to express a number; and adds, that if the common progression were from 12 to 12, or from 16 to 16, it would be still more expeditious.

**BINARY measure**, in music, is a measure which is beaten equally, or where the time of rising is equal to that of falling. This is usually called common time. See **MUSIC**.

**BINARY number**, that composed of two units.

**BINDBROKE**, a market-town of Lincolnshire, about twenty-five miles north-east of Lincola; E. long. 6', and N. lat. 53° 32'.

**BINCH**, a little fortified town of Hainault, ten miles east of Mons; E. long. 4° 20', and N. lat. 50° 30'.

**BIND**, a country-word for a stalk of hops.

**BIND of eels**, a quantity, consisting of 250, or 10 strikes, each containing 25 eels.

**BINDING**, in a general sense, the fastening of two or more together by a vinculum or bond.

**Book-BINDING**. See **BOOK-BINDING**.

**BINDING**, among fencers, denotes the securing the adversary's sword, which is effected by a pressure and spring from the wrist.

- **BINDING**,



- BINDING**, in falconry, a term which implies tiring, or when a hawk seizes.
- BINDING and LOOSING**, in a theological sense, the same with absolution.
- BIND-WEED**, in botany. See **CONVOLVULUS**.
- BING**, in the alum-works, denotes a heap of alum thrown together in order to drain.
- BINGEN**, a town of the electorate of Mentz, about sixteen miles west of that city; E. long.  $7^{\circ} 20'$ , and N. lat.  $50^{\circ}$ .
- BINGLEY**, a market-town in the west riding of Yorkshire, about thirty miles west of York; W. long.  $1^{\circ} 40'$ , and N. lat.  $53^{\circ} 45'$ .
- BINN**, in country affairs, a place boarded up to put corn in.
- BINOCULAR telescope**, a kind of dioptric telescope fitted with two tubes, joined in such a manner that one may see a distant object with both eyes at the same time.
- BINOMIAL**, in algebra, a root consisting of two members connected by the sign + or —. Thus  $a+b$ , and  $8-3$  are binomials, consisting of the sums and differences of these quantities. See **ALGEBRA**, Chap. I.
- BIOGRAPHER**, one who writes the lives of particular persons, as Plutarch, Suetonius, &c. See the next article.
- BIOGRAPHY**, a species of history which records the lives and characters of remarkable persons. This is at once the most entertaining and instructive kind of history. It admits of all the painting and passion of romance; but with this capital difference, that our passions are more keenly interested, because the characters and incidents are not only agreeable to nature, but strictly true. It is much to be regretted that this kind of history is so much neglected. No books are so proper to be put into the hands of young people.
- BIORNBURG**, a town of Finland, situated on the eastern shore of the Bothnic gulph; E. long.  $21^{\circ}$ , and N. lat.  $62^{\circ}$ .
- BIOTHANATI**, a term sometimes used for suicides. See **SUICIDES**.
- BIOUAC**, in military affairs, 'a night-guard, performed' by the whole army, when there is any apprehension of danger from the enemy.
- BIPENNIS**, in Roman antiquity, an axe with a double edge, one of which was used in stabbing, and the other in cutting.
- BIQUADRATIC power**. See **ALGEBRA**, Chap. XIII.
- BIQUADRATIC root**. See **ALGEBRA**, Chap. XIII.
- BIQUADRATIC equation**. See **ALGEBRA**, Chap. XIII.
- BIQUINTILE**, an aspect of the planets, when they are  $144$  degrees from each other.
- BIR**, a city of Diarbeck, or Mesopotamia, situated on the river Euphrates, about seventy miles south-east of Aleppo, in  $40^{\circ}$  E. long. and  $35^{\circ} 20'$  N. lat.
- BIRCH-TREE**, in botany. See **BETULA**.
- BIRD**, in zoology. See **NATURAL HISTORY**, and **AVIS**.
- BIRD of paradise**. See **PARADISEA**.
- Black-BIRD**, the English name of the turdus. See **TURDUS**.
- BIRDS**, in heraldry, according to their several kinds, represent either the contemplative or active life. They are the emblems of liberty, expedition, readiness, swiftness, and fear. They are more honourable bearings than fishes, because they participate more of air and fire, the two noblest and highest elements, than of earth and water.
- Birds must be borne in coat-armour, as is best fitting the propriety of their natural actions of going, sitting, standing, flying, &c.
- Birds that are either whole footed, or have their feet divided, and yet have no talons, are said to be membered; but the cock, and all birds of prey with sharp and hooked beaks and talons, for encounter or defence, are termed armed. In the blazoning of birds, if their wings be not displayed, they are said to be borne close; as, *he beareth an eagle*, &c. close.
- BIRD-CALL**, among sportsmen. See **CALL**.
- BIRD'S-EYE**, in botany. See **PRIMULA**.
- BIRD-LIME**, a viscid substance, prepared after different ways. The most common bird-lime among us, is made from holly-bark, boiled ten or twelve hours; when the green coat being separated from the other, it is covered up a fortnight in a moist place, then pounded into a tough paste, so that no fibres of the wood are discernible, and washed in a running stream till no motes appear; put up to ferment four or five days, skimmed as often as any thing arises, and laid up for use. To use it, a third part of nut-oil, or thin grease, must be incorporated with it over the fire.
- The Italians make bird-lime of the berries of the mistle-tree. That which comes from Damascus is supposed to be made of sebastes; and it is said that the bark of our Linnaea, or way-faring shrubs, will make very good bird-lime.
- BIREMIS**, in Roman antiquity, a vessel with two rows of oars; concerning the disposition of which authors are not agreed.
- BIRETUM**, or **BIRRETUM**, a sort of black bonnet, or covering of the head, in form of a pyramid, much used in Italy and France about five or six hundred years ago, as a badge of victory, honour, or sacerdotal preferment.
- BIRKENFIELD**, a town of Germany, about 40 miles west of Mentz, situated in  $6^{\circ} 40'$  E. long. and  $49^{\circ} 45'$  N. lat.
- BIRMINGHAM**, a large populous town in Warwickshire, about 16 miles north-west of Coventry, situated in  $1^{\circ} 50'$  W. long. and  $52^{\circ} 30'$  N. lat. It is remarkable for its iron manufactory.
- BIROTA**, or **BIROTUM**, in Roman antiquity, a kind of vehicle, so denominated from its moving upon two wheels. It carried about two hundred pound weight, and was drawn by three mules.
- BIRRUS**, in Roman antiquity, a cloak, made of woollen cloath, worn by the soldiers: Also a robe worn by the priests or bishops.
- BIRTH**, in midwifery, signifies the same with delivery. See **DELIVERY**, and **MIDWIFERY**.
- AFTER-BIRTH**. See **AFTER-birth**.
- BIRTH**, or **BIRTHING**, in the sea-language, a convenient

nient place to moor a ship in; also a due distance observed by ships lying at anchor, or under sail; and a proper place aboard for a mess to put their chests, &c. is called the birth of that mess.

**BIRTH-WORT**, in botany. See **ARISTOLOCHIA**.

**BIRZA**, a town of Samogitia, in Poland, about 42 miles south-east of Mittau, situated in 25° E. long. and 56° 35' N. lat.

**BISA**, or **BIZA**, a coin of Pegu, which is current there for half a ducat. It is also a weight used in that kingdom.

**BISANT**. See **BESANT**.

**BISCAY**, the most northerly province of Spain, from which the bay of Biscay takes its name.

**New BISCAY**, a province of Mexico, having New-Mexico on the north, and Florida on the west.

**BISCHWELLER**, a fortress of Alsace, subject to the French, situated about five miles west of Port-Lewis, in 7° E. long. and 48° 40' N. lat.

**BISCHROMA**, in music, the same as our triple quaver. See **CHROMA**.

**BISCUTELLA**, in botany, a genus of the tetradynamia filiculosa class. The pod is plain, compressed, roundish, and bilobed above and below; and the calix is a small leaf, gibbous at the base. The species are two, *viz.* the auriculata and didyma, both natives of Italy, &c.

**BISERRULA**, in botany, a genus of the diadelphica decandria class. The pod is plain, and has two cells. There is but one species, *viz.* the pelecinus, a native of Sicily.

**BISERTA**, a port-town of the kingdom of Tunis, in Africa, situated on the Mediterranean, near the place where Utica anciently stood, and about forty miles north of Tunis, in 9° E. long. and 37° N. lat.

**BISHOP**, a prelate, or person consecrated for the spiritual government of a diocese.

In the primitive church, it appears that there was but one bishop in a church, and but one church to a bishop. The peculiar acts of the episcopal function were, preaching the word, praying with the people, administering the two sacraments of baptism and the eucharist, taking care of the poor, ordaining of ministers, governing his flock, excommunicating offenders, and absolving penitents. The election of a bishop was jointly in the hands of the clergy and laity of the bishopric or parish which became vacant. When they elected a bishop, they presented him to the neighbouring bishops, for their approbation and consent, without which his election was not valid. A bishop thus chosen and ordained, always gave notice of his advancement to the most renowned bishops of the church.

As to the form of ordination, it was thus: Two bishops held the book of the gospels over the head of that bishop which was ordained, and whilst one pronounced the blessing, or prayer of consecration, all the rest of the bishops that were present laid their hands upon his head.

In the church of Rome, the pope has the chief right of electing bishops; nevertheless, some princes have reserved to themselves the right of nominating to

bishoprics, after which the pope sends his approbation, and the bulls to the new bishop.

When a person hears that the pope has raised him to the episcopal dignity, he enlarges his shaven crown, dresses himself in purple, and, if he be in Rome, he must go and receive the rochet from the pope: three months after, having been confirmed in his election, he is consecrated in a very solemn manner.

Upon the vacancy of a bishop's see in England, the king grants his *conge d'eslire* to the dean and chapter, to elect the person whom, by his letters missive, he hath appointed; and if they do not make the election in twenty days, they are to incur a premonire. The dean and chapter having made their election accordingly, the archbishop, by the king's direction, confirms the bishop, and afterwards consecrates him, by imposition of hands, according to the form laid down in the Common Prayer-book. Hence we see that a bishop differs from an archbishop in this, that an archbishop with bishops consecrates a bishop, as a bishop with priests consecrates a priest: Other distinctions are, that an archbishop visits a province, as a bishop a diocese; that an archbishop convokes a provincial synod, as a bishop does a diocesan one; and that the archbishop has canonical authority over all the bishops of his province, as a bishop has over the priests of his diocese.

The jurisdiction of a bishop of the church of England consists in collating benefices, granting institutions, commanding inductions, taking care of the profits of vacant benefices for the use of the successors, consecrating churches and chapels, ordaining priests and deacons, confirming after baptism, granting administrations, and taking probates of wills: These parts of his function depend upon the ecclesiastical law. By the common law, he is to certify to the judges concerning legitimate and illegitimate births and marriages: And to his jurisdiction, by the statute-law, belongs the licensing of physicians, surgeons, and school-masters, and the uniting of small parishes: which last privilege is now peculiar to the bishop of Norwich.

All bishops of England are peers of the realm, except the bishop of Man, and as such sit and vote in the House of Lords: They are barons in a threefold manner, *viz.* feudal, in regard to the temporalities annexed to their bishoprics; by writ, as being summoned by writ to parliament; and lastly, by patent and creation: Accordingly they have the precedence of all other barons, and vote as barons and bishops, and claim all the privileges enjoyed by the temporal lords, excepting that they cannot be tried by their peers, because, in cases of blood, they themselves cannot pass upon the trial, for they are prohibited, by the canons of the church, to be judges of life and death.

**BISHOP'S COURT**, an ecclesiastical court, held in the cathedral of each diocese, the judge whereof is the bishop's chancellor, who judges by the civil and canon law; and if the diocese be large, he has his commissaries in remote parts, who hold what they call *consistory courts*, for matters limited to them by their commission.

**BISHOP'S**

**BISHOP'S-CASTLE**, a borough-town in Shropshire, situated on the river Ony, about 15 miles south-west of Shrewsbury, in 3° W. long. and 52° 30' N. lat.

**BISHOP AND HIS CLERKS**, some little islands and rocks on the coast of Pembrokeshire, not far from St David's, very fatal to mariners.

**BISHOP'S-STORTFORD**, a market-town in Hertfordshire, 30 miles north of London, and only 10 miles north-east of Hertford; in 20° E. long. 51° 30' N. lat.

**BISHOPING**, a term among horse-courfers, to denote the sophistications used to make an old horse appear young, a bad one good, &c.

**BISHOPRIC**, the district over which a bishop's jurisdiction extends, otherwise called a diocese.

In England there are twenty-four bishoprics, and two archbishoprics; in Scotland, none at all; in Ireland, eighteen bishoprics, and four archbishoprics.

**BISIGNANO**, a city of Hither Calabria, in the kingdom of Naples; in 16° 45' E. long. and 39° 50' N. lat.

**BISKET**, a kind of bread prepared by the confectioners, of fine flour, eggs, and sugar, and rose or orange-water; or of flour, eggs, and sugar, with aniseeds and citron-peel, baked again and again in the oven, in tin or paper moulds. There are divers sorts of biscuits, as seed-biscuit, fruit-biscuit, long biscuit, round biscuit, naples-biscuit, sponge-biscuit, &c.

**Sea-BISKET** is a sort of bread much dried by passing the oven twice, to make it keep for sea-service. For long long voyages they bake it four times, and prepare it six months before the embarkation. It will hold good a whole year.

**BISMILLA**, a solemn form used by the Mahometans at the beginning of all their books and other writings, signifying, *In the name of the most merciful God.*

**BISMUTH**, a ponderous brittle semi-metal, resembling zinc and the regulus of antimony, but differing greatly from them in quality. It dissolves with vehemence in the nitrous acid, which only corrodes the regulus of antimony; and is scarce soluble in the marine acid, which acts strongly on zinc. A calx and flowers of bismuth have been recommended as similar in virtue to certain antimonial preparations; but are at present of no other use than as a pigment or cosmetic.

Bismuth is sometimes found native, in small compact masses, of a pale lead-colour on the outside, but a silvery white within. It attenuates the parts of all other metals, and thereby promotes their fusion. When dissolved in strong acids, it yields the famous cosmetic magistery, and is a very valuable ingredient in the mixed metals used in casting types, and for bell-metal.

Bismuth is very common in Germany, and not unfrequently found in the tin-mines of Cornwall, though little known, or at least regarded, there.

**BISNAGER**, the capital of a province of the same name in the higher peninsula of India; in 78° E. long. and 14° N. lat.

**BISNOW**, or **BISCHNOU**, a sect of the B-nians in the East Indies; they call their god Ram-ram, and give him a wife: They adorn his image with golden chains, necklaces of pearls, and all sorts of precious stones.

They sing hymns in honour of their god, mixing their devotion with dances and the sound of drums, flagelets, brazen basons, and other instruments. This sect lives wholly upon herbs and pulse, butter and milk.

**BISOCHI**, or **BIZOCHI**. See **BIZOCHI**.

**BISOMUM**, or **DISOMUM**, in Roman antiquity, a sepulchre, or vault, containing two dead bodies. On the tombs of the primitive Christians were wont to be inscribed the words *bisomi*, or *trisomi*, or *quadrisomi*, &c. that by these means they might the easier calculate the number of their dead.

**BISON**, in zoology, the trivial name of a species of bos. See **BOS**.

**BISQUET**, or **BISKET**. See **BISKET**.

**BISSACRAMENTALES**, a denomination given to Protestants, on account of their allowing of only two sacraments, *viz.* baptism and the eucharist.

**BISSECTION**, in geometry, the division of a line, angle, &c. into two equal parts.

**BISSELÆUM**, among ancient naturalists, denotes the oil of pitch, more properly called *pisselaum*. See **PISSELÆUM**.

**BISSEXTILE**, in chronology, a year consisting of 366 days, being the same with our leap-year. See **ASTRONOMY**, *Of the division of time.*

**BISTER**. See **BISTRÉ**.

**BISTI**, in commerce, a small coin of Persia: Some say that it is among the current silver coins of Persia, and worth only a little above three farthings of our money; others speak of it again as a money of account.

**BISTORTA**, in botany, the trivial name of a species of polygonum. See **POLYGONUM**.

**BISTOURY**, in surgery, an instrument for making incisions, of which there are different kinds, some being of the form of a lancet, others straight and fixed in the handle like a knife, and others crooked with the sharp edge on the inside. See **SURGERY**.

**BISTRE**, or **BISTRÉ**, among painters, denotes glossy foot, pulverised and made into a kind of cakes, with gum-water. It is used to wash their designs. See **WASHING**.

**BIT**, or **BITT**, an essential part of a bridle. Its kinds are various. 1. The musrol, snaffle, or watering-bit. 2. The canon-mouth, jointed in the middle. 3. The canon with a fast mouth, all of a piece, only kneed in the middle, to form a liberty or space for the tongue; fit for horses too sensible, or ticklish, and liable to be continually bearing on the hand. 4. The canon-mouth, with the liberty in form of a pigeon's neck; proper where a horse has too large a tongue. 5. The canon with a port mouth, and an upset or mounting liberty; used where a horse has a good mouth, but large tongue. 6. The scatch-mouth, with an upset; ruder but more secure than a canon-mouth. 7. The canon-mouth with a liberty; proper for a horse with a large tongue, and round bars. 8. The masticadour, or slaving-bit, &c. The several parts of a snaffle, or curb-bit, are the mouth piece, the cheeks and eyes, guard of the cheek, head of the cheeks, the port, the welts, the campanel or curb and hook, the bosses, the bolsters and rabbits, the water-chains, the side-bolts, bolts,

- bolts, and rings, kirbles of the bit or curb, trench, top-rol, flap, and jeive. The importation of bits for bridles is now prohibited.
- BIT** also denotes the iron part of a piercer, augre, and the like instruments.
- BIT of a key**, the part which contains the wards. See **WARDS**.
- BIT**, or **BITTS**, in ship-building, the name of two great timbers, usually placed abast the manger, in the ship's loof, through which the cross piece goes: The use of it is to belay the cable thereto, while the ship is at anchor.
- BITCH**, the female of the dog kind. See **CANIS**.
- BITONTO**, a city of the province of Barri, in the kingdom of Naples, situated about eight miles south-west of Barri, in  $17^{\circ} 40' E$  long. and  $41^{\circ} 20' N$  lat.
- BITTACLE**, on ship-board, a square box standing before him that steers the ship, with the compass placed therein, to keep and direct the ship in her course.
- BITTER**, an epithet given to all bodies of an opposite taste to sweetness. For the medical virtues of bitters, see **MATERIA MEDICA**.
- BITTER**, a sea-term, signifying any turn of the cable about the bits, so as that the cable may be let out by little and little. And when a ship is stopped by a cable, she is said to be brought up by a bitter. Also that end of the cable which is wound about the bits is called the bitter end of the cable.
- BITTER-APPLE**, in botany. See **COLOCYNTHIS**.
- BITTER-SALT**. See **EPSOM-SALT**.
- BITTER-SWEET**, in botany. See **SOLANUM**.
- BITTER-WATERS**. See **WATER**.
- BITTER-WINE**. See **WINE**.
- BITTERN**, in ornithology. See **ARDEA**.
- BITTERN**, in the salt-works, the brine remaining after the salt is concreted: This, they ladle off, that the salt may be taken out of the pan, and afterwards put in again; when, being farther boiled, it yields more salt. See **SALT**.
- BITUMEN**, in natural history. See **ASPHALTUM**.
- BIVALVES**, a term sometimes used for such shells as consist of two pieces. It is also an appellation given to such pods, or capsules, as consist of two valves inclosing the seeds.
- BIVENTER**, in anatomy, called also digastric, or two-bellied, a muscle of the lower jaw. See p. 222. col. 1.
- BIUMBRES**, in geography, the same with the *amphiscii*. See **AMPHISCII**.
- BIXA**, in botany, a genus of the polyandria mongynia class. The corolla consists of 10 petals; the calix has five teeth; and the capsule is rough, and double-valved. There is but one species, viz. the orellana, a native of America.
- BIZARRO**, in the Italian music, denotes a fanciful kind of composition, sometimes fast, slow, soft, strong, &c. according to the fancy of the composer.
- BIZOCHI**, or **BISOCHI**, in church-history, certain heretical monks, said to have assumed the religious habit contrary to the canons, rejected the sacraments, and maintained other errors.
- BIZU**, a town of Barbary, in Africa, in the kingdom of Morocco.
- BLACK**, a well known colour, supposed to be owing to the absence of light; all the rays thereof being absorbed by the black bodies. See **OPTICS**.
- BLACK**, among dyers, one of the five simple and mother colours used in dying. It is made differently, according to the several qualities of the stuffs that are to be dyed. For stuffs of a high price, as woollen cloth an ell and a half or an ell and a quarter wide, broad and narrow rattens, fine woollen druggets, &c. they must use a black made of the best woad and indigo, inclining to a bluish brown. The goodness of the composition consists in there being not above six pounds of indigo ready prepared to each ball of woad, when the latter, being in the tub, begins to cast its blue flower; and in not being heated for use above twice; after which it must be boiled with alum, tartar, or ashes of lees of wine, then maddered with common madder, and lastly the black must be given with gall-nuts of Aleppo, copperas, and fumach. As for more indifferent stuffs, such as small rattens, and shalloons, as they cannot pay for the expence of maddering, it is sufficient that they be well boiled with woad, and afterwards blacked with gall and copperas. There is likewise jesuits black, which is made with the same ingredients as the good black, but without having first dyed the stuff blue.
- German BLACK**, called by some Frankfort black, is made with the lees of wine, burnt, washed afterwards in water, then ground in mills made for that purpose, with ivory, bones, or peach-stones, also burnt. It comes from Frankfort, Mentz, and Strasbourg, either in lumps or powder, and must be chosen moist, without having been wetted, of a fine shining black, soft, friable, light, and with as few shining grains as possible.
- Ivory BLACK**, otherwise called velvet black, is burnt ivory, which becoming quite black, and being reduced to thin plates, is ground in water, and made into troches, to be used by painters, and by jewellers, who set precious stones, to blacken the ground of the collets, and give the diamonds a teint or foil. In order to be good, it ought to be tender, friable, and thoroughly ground.
- Bone-BLACK** is made with the bones of oxen, cows, &c. and is used in painting; but is not so much esteemed as ivory black.
- Hart's-BLACK**, that which remains in the retort after the spirits, volatile salt, and oil, have been extracted from hart's-horn. It answers the purposes of painters almost as well as ivory-black.
- Spanish BEACK** is nothing but burnt cork: It is used in several works. It should be light, and have as few grains of sand mixed with it as possible.
- Lamp-BLACK**, or **Lam-BLACK**, the sooty smoke of rosin. There is some in powder and some in lumps, and is mostly brought from Sweden and Norway, and pays duty 1 l. 10 s. 4  $\frac{1}{2}$  d. the hundred weight. It is used on various occasions, particularly for making the printer's ink, for which purpose it is mixed with oil of walnuts, or linseed, and turpentine, all boiled together.
- Earth-BLACK**, a sort of coals found in the ground, with which the painters and limners use to paint in fresco, after it has been well ground.

There

- There is also a black made with gall-nuts, copperas, or vitriol, such as common ink. And a black made with silver and lead, which serves to fill up the cavities of engraved things.
- Currier's BLACK**, a black made with gall-nuts, four beer, and old iron, termed the first black. The second black, which gives the gloss to the leather, is composed of gall-nuts, copperas, and gum-arabic.
- BLACK-bank**, in geography, a town of Ireland, about seven miles south of Armagh, in  $6^{\circ} 50'$  W. long. and  $54^{\circ} 12'$  N. lat.
- BLACK-berry**, in botany. See **RUBUS**.
- BLACK-book of the exchequer**. See **EXCHEQUER**.
- BLACK-bourn**, a market-town of Lancashire, about nine miles east of Preston, in  $2^{\circ} 20'$  W. long. and  $53^{\circ} 40'$  N. lat.
- BLACK-cap**, in ornithology, the English name of the *Muscicapa utricapilla*. See **MUSCICAPA**.
- BLACK-eagle**. See **FALCO**.
- BLACK-forest**, a part of Swabia, divided from Switzerland by the river Rhine.
- BLACK-game**. See **TETRAO**.
- BLACK-mail**, a link of mail, or small pieces of metal or money. In the counties of Northumberland, Cumberland, Westmoreland, and several parts of Scotland, it was formerly taken for a certain rent of money, corn, cattle, or other consideration, paid by poor people near the borders, to persons of note and power, allied with some moss-troopers, or known robbers, in order to protect them from pillage.
- BLACK-order**. See **ORDER**.
- BLACK-rod**. See **ROD**.
- BLACK-sea**, the same with the Euxine sea, lying north of Natolia, between  $29^{\circ}$  and  $44^{\circ}$  E. long. and  $42^{\circ}$  and  $46^{\circ}$  N. lat.
- BLACK-tin**. See **TIN**.
- BLACK-water**, the name of two rivers in Ireland; one of which runs through the counties of Cork and Waterford, and falls in Youghal bay; and the other, after watering the county of Armagh, falls into Lough Neagh.
- BLACKS**, in physiology. See **NEGROES**.
- BLADDER**, in anatomy. See p. 269. col. 2.
- Air-BLADDER**, in physiology. See **AIR**.
- Oil-BLADDERS**. See **OIL**.
- BLÆRIA**, in botany, a genus of the tetrandria monogynia class. The calix is divided into four segments, as also the corolla; the stamina are inserted into the receptacle; and the capsule has four cells, containing many seeds. There is but one species, *viz.* the *crioides*, a native of the cape of Good Hope.
- BLAFART**, in commerce, a small coin, current at Cologne, worth something more than a farthing of our money.
- BLAIN**, among farriers, a distemper incident to beasts, being a certain bladder growing on the root of the tongue, against the wind-pipe, which swells to such a pitch as to stop the breath. It comes by great chafing and heating of the stomach, and is perceived by the beast's gaping and holding out his tongue, and foaming at the mouth. To cure it, cast the beast, take forth his tongue, and then, sitting the bladder, wash it gently with vinegar and a little salt.
- BLAIR of Athol**, a small town of Athol in Scotland, situated about twenty-eight miles north of Perth.
- BLAIRIA**, in botany. See **VERBENA**.
- BLAKEA**, in botany, a genus of the dodecandria monogynia class. The calix has five leaves; the petals are six; the antheræ are connected; and the capsule has six cells. There is only one species, *viz.* the *trinervia*, a native of Jamaica.
- BLAMONT**, a town of Lorraine, about twenty-eight miles south-east of Nancy, in E. long.  $6^{\circ} 45'$  and N. lat.  $48^{\circ} 38'$ .
- BLANC**. See **BLANK**.
- BLANCH-holding**, in Scots law, a tenure by which the vassal is only bound to pay an elusory yearly duty to his superior merely as an acknowledgment of his right. See **SCOTS LAW**, tit. *The several kinds of holdings*.
- Carte-BLANCHE**. See **CARTE**.
- BLANCHING**, in a general sense, denotes the art of bleaching or whitening.
- BLANCHING** of copper is done various ways, so as to make it resemble silver. If it be done for sale, it is felony by 8 and 9 William III. chap. xxvi.
- BLANCHING**, in coinage, the operation performed on the planchets or pieces of silver, to give them the requisite lustre and brightness. They also blanch pieces of plate, when they would have them continue white, or have only some parts of them burnished.
- Blanching, as it is now practised, is performed by heating the pieces on a kind of peel with a wood-fire, in the manner of a reverberatory; so that the flame passes over the peel. The pieces being sufficiently heated and cooled again, are put successively to boil in two pans, which are of copper: In these they put water, common salt, and tartar of Montpellier. When they have been well drained of this water in a copper sieve, they throw sand and fresh water over them; and when dry, they are well rubbed with towels.
- BLANCHING**, among gardeners, an operation whereby certain sallots, roots, &c. are rendered whiter than they would otherwise be.
- It is this: After pruning off the tops and roots of the plants to be blanched, they plant them in trenches about ten inches wide, and as many deep, more or less, as is judged necessary; as they grow up, care is taken to cover them with earth, within four or five inches of their tops: This is repeated from time to time, for five or six weeks, in which time they will be fit for use, and of a whitish colour where covered by the earth.
- BLANCHING** also denotes the operation of covering iron plates with a thin coat or crust of tin.
- BLANCO**, or **Cape-BLANCO**, a promontory of Peru, in S. America, W. long.  $81^{\circ}$ , and S. lat.  $3^{\circ} 45'$ .
- BLANCO** is also the name of one of the Antille-islands, on the coast of Terra Firma, in W. long.  $64^{\circ}$ , and N. lat.  $12^{\circ}$ .
- Cape-BLANCO** is also a promontory of Africa, in  $18^{\circ}$  W. long. and  $20^{\circ}$  N. lat.
- BLANFORD**; a market town of Dorsetshire, ten miles north

north of Pool, in 2° 20' W. long. and 50° 50' N. lat.

**BLANES**, a port-town of Catalonia in Spain, E. long. 2° 40', N. lat. 41° 30'.

**BLANK**, or **BLANC**, properly signifies white. See **WHITE**.

**BLANK**, in commerce, a void or unwritten place which merchants sometimes leave in their day-books or journals.

**BLANK-bar**, in law, the same with common bar. See **BAR**.

**BLANK-verse**, in the modern poetry, that composed of a certain number of syllables, without the assistance of rhyme. See **VERSE** and **RHIME**.

**Point-BLANK**. See **POINT-blank**.

**BLANKENBURG**, a town of Dutch Flanders, eight miles north-east of Ostend, in 3° E. long. and 51° 20' N. lat.

**BLANKENBURG** is also the name of a town in lower Saxony, about forty-five miles south-east of Wolfembutte, in 11° 15' E. long. and 51° 50' N. lat.

**BLANKET**, a coverlet for a bed. A stuff commonly made of white wool, and wrought in a loom like cloth; with this difference, that they are crossed like ferges.

When they come from the loom, they are sent to the fuller; and after they have been fulled and well cleaned, they are naped with a fuller's thistle.

There are blankets made with the hair of several animals; as that of goats, dogs, and others.

French blankets, called *Paris mantles*, pay duty 12s. 11 d. each, if coloured and the manufacture of France; otherwise only 5s. 17<sup>6</sup>/<sub>8</sub> d. If uncoloured, and the manufacture of France, they pay each 9s. 8<sup>3</sup>/<sub>8</sub> d. otherwise only 3s. 10<sup>3</sup>/<sub>8</sub> d. Blankets imported into France, pay a duty of importation according to their fineness; namely, those of fine wool, six livres *per* piece; those of coarse and middling wool, three livres. None can be imported but by the way of Calais and St Vallery.

**BLANOS**, a maritime town of Spain in Catalonia, near the mouth of the river Tordera.

**BLANQUILLE**, in commerce, a small silver coin current in the kingdom of Morocco, and all that part of the coast of Barbary; it is worth about three-half-pence of our money.

**BLARE**, in commerce, a small copper coin of Bern, nearly of the same value with the ratz.

**BLAREGNIES**, a town of the Austrian Netherlands, about seven miles south of Mons; E. long. 3° 55', and N. lat. 50° 30'.

**BLASIA**, in botany, a genus of the cryptogamia algae class. The calix of what is called the male is cylindrical, and full of grains; the calix of the female is naked, and inclosing a roundish seed sunk in the leaves. There is but one species, *viz.* the pusilla, or dwarf blasia, a native of Britain.

**BLASPHEMY**, an indignity or injury offered to the Almighty, by denying what is his due, and of right belonging to him; or by attributing to the creature that which is due only to the Creator.

**BLAST**, in a general sense, denotes any violent explosion of air, whether occasioned by gun-powder, or by the action of a pair of bellows.

**BLASTS**, among miners, the same with damp. See **DAMPS**.

**BLAST**, or **BLIGHT**, in husbandry. See **BLIGHT**.

**BLASTING**, a term used by miners for the tearing up rocks which lie in their way, by the force of gun-powder.

**BLATTA**, or **COCKROCHE**, a genus of insects belonging to the order of hemiptera, or such as have four semicrustaceous incumbent wings. The head of the blatta is inflected towards the breast; the antennæ, or feelers, are hard like bristles; the elytra and wings are plain, and resemble parchment; the breast is smooth, roundish, and is terminated by an edge or margin; the feet are fitted for running; and there are two small horns above the tail. This insect resembles the beetle; and there are 10 species; *viz.* 1. The gigantea is of a livid colour, and has square brownish marks on the breast. It is found in Asia and Africa, and is about the size of a hen's egg. 2. The alba is red, and the margin of the breast is white. It is found in Egypt. 3. The furinamentis is livid, and the breast edged with white. It is a native of Surinam. 4. The americana is of an iron colour, and the hind part of the breast is white. The wings and elytra are longer than its body. It is found in America and the south of France. 5. The pivea is white, with yellow feelers. It is a native of America. 6. The africana is ash-coloured, and has some hairs on its breast. It is found in Africa. 7. The orientalis is of a dusky ash colour, has short elytra, with an oblong furrow in them. This species is frequent in America. They get into chests, &c. and do much hurt to cloaths; they infest peoples beds in the night, bite like bugs, and leave a very unfavoury smell behind them. They avoid the light, and seldom appear but in the night time. The female resembles a kind of caterpillar, as it has no wings: She lays an egg of about one half the bulk of her belly. They eat bread, raw or dressed meat, linen, books, silk-worms and their bags, &c. Sir Hans Sloane says, that the Indians mix their ashes with sugar, and apply them to ulcers in order to promote the suppuration. 8. The germanica, is livid, and yellowish, with two black parallel lines on the breast. It is found in Denmark. 9. The lapponica, is yellow, and the elytra are spotted with black. It is found in Lapland, and feeds upon cheese, fishes, &c. 10. The oblongata, is of an oblong figure; the colour is livid and shining; and it has two black spots on the breast. The feelers are red and clavated; and the feet are very hairy. It is a native of America.

**BLATTA byzantia**, in pharmacy. See **UNGUIS**.

**BLATTARIA**, in botany. See **VERBASCUM**.

**BLAVET**, or **PORT-LEWIS**, a port-town of Brittany in France, situated at the mouth of the river Blavet; W. long. 3°, and N. lat. 47° 40'.

**BLAWBUREN**, a town of Swabia, in Germany, about eleven miles east of Ulm; E. long. 9° 45', and N. lat. 48° 24'.

**BLAYE**,

**BLAYE**, a fortress of Guienne, in France, situated on the river Garonne, about twenty-one miles north of Bourdeaux; W. long. 45°, and N. lat. 45° 70'.

The intention of it is, to hinder any ship from going to Bourdeaux without permission.

**BLAZE**, a white spot in a horse's face.

**BLAZE**. See **BLARE**.

**BLAZONING**, or **BLAZONRY**, in heraldry, the deciphering the arms of noble families.

The word originally signified the blowing or wind-

ing of a horn, and was introduced into heraldry as a term denoting the description of things borne in arms, with their proper significations and intendments, from an ancient custom the heralds, who were judges, had of winding an horn at jousts and tournaments, when they explained and recorded the achievements of knights.

**BLEA**, in the anatomy of plants, the inner rind or bark. See **AGRICULTURE**, Part I.

## B L E A C H I N G.

**BLEACHING** is the art of whitening linen cloth, thread, &c.; which is conducted in the following manner by the bleachers of this country.

After the cloth has been sorted into parcels of an equal fineness, as near as can be judged, they are latched, linked, and then steeped. Steeping is the first operation which the cloth undergoes, and is performed in this manner. The linens are folded up, each piece distinct, and laid in a large wooden vessel; into which is thrown, blood-warm, a sufficient quantity of water, or equal parts of water and lye, which has been used to white cloth only, or water with rye-meal or bran mixed with it, till the whole is thoroughly wet, and the liquor rises over all. Then a cover of wood is laid over the cloth, and that cover is secured with a post betwixt the boards and the joisting, to prevent the cloth from rising during the fermentation which ensues. About six hours after the cloth has been steeped in warm water, and about twelve in cold, bubbles of air arise, a pellicle is formed on the surface of the liquor, and the cloth swells when it is not pressed down. This intestine motion continues from thirty-six to forty-eight hours, according to the warmth of the weather; about which time the pellicle or scum begins to fall to the bottom. Before this precipitation happens, the cloth must be taken out; and the proper time for taking it out, is when no more air-bubbles arise. This is allowed to be the justest guide by the most experienced bleachers.

The cloth is then taken out, well rinsed, disposed regularly by the selvage, and washed in the put-mill to carry off the loose dust. After this it is spread on the field to dry: When thoroughly dried, it is ready for bucking; which is the second operation.

Bucking, or the application of salts, is performed in this manner. The first, or mother lye, is made in a copper, which we shall suppose, for example, when full, holds 170 Scots gallons of water. The copper is filled three fourths full of water, which is brought to boil: just when it begins, the following proportion of ashes is put into it, viz. 30 lb. of blue, and as much white pearl-ashes; 200 lb. of Marcockt ashes, (or, if they have not these, about 300 lb. of Cahub); 300 lb. of Muscovy, or blanch ashes; the three last ought to be well pounded.

This liquor is allowed to boil for a quarter of an hour, stirring the ashes from the bottom very often; after which the fire is taken away. The liquor must stand till it has settled, which takes at least six hours, and then it is fit for use.

Out of their first, or mother-lye, the second, or that used in bucking, is made in this manner. Into another copper, holding, for example, 40 Scots gallons, are put 38 gallons of water, 2 lb. soft soap, and 2 gallons of mother-lye; or, for cheapness, in place of the soap, when they have lye which has been used to white linen, called *white-linen lye*, they take 14 gallons of it, leaving out an equal quantity of water. This is called *bucking-lye*.

After the linens are taken up from the field dry, they are set in the vat or cave, as their large vessel is called, in rows, endwise, that they may be equally wet by the lye; which, made blood-warm, is now thrown on them, and the cloth is afterwards squeezed down by a man with wooden shoes. Each row undergoes the same operation, until the vessel is full, or all the cloth in it. At first the lye is put on milk-warm, and, after standing a little time on the cloth, it is again let off by a cock into the bucking-copper, heated to a greater degree, and then put on the cloth again. This course is repeated for six or seven hours, and the degree of heat gradually increased, till it is, at the last turn or two, thrown on boiling hot. The cloth remains after this for three or four hours in the lye; after which the lye is let off, thrown away, or used in the first buckings, and the cloth goes on to another operation.

It is then carried out, generally early in the morning, spread on the grass, pinned, corded down, exposed to the sun and air, and watered for the first six hours, so often, that it never is allowed to dry. Afterwards it is allowed to lie till dry spots appear before it is watered. After seven at night it gets no more water, unless it be a very drying night. Next day, in the morning and forenoon, it is watered twice or thrice if the day be very dry; but if the weather be not drying, it gets no water: After which it is taken up dry if the green be clean; if not, it is rinsed, mill-washed, and laid out to dry again, to become fit for bucking.

This alternate course of bucking and watering, is performed for the most part, from ten to sixteen times, or more, before the linen is fit for souring; gradually increasing the strength of the lye from the first to the middle bucking, and from that gradually decreasing it till the souring begins. The lyes in the middle buckings are generally about a third stronger than the first and last.

Souring, or the application of acids to cloth, is the fourth operation. It is difficult to say when this operation should commence, and depends mostly on the skill and experience of the bleacher. When the cloth has an equal colour, and is mostly freed from the sprat, or outer bark of the lint, it is then thought fit for souring; which is performed in the following manner. Into a large vat or vessel is poured such a quantity of butter-milk, or sour milk, as will sufficiently wet the first row of cloth; which is tied up in loose folds, and pressed down by two or three men bare-footed. If the milk is thick, about an eighth of water is added to it; if thin, no water. Sours made with bran, or rye-meal and water, are often used instead of milk, and used milk-warm. Over the first row of cloth a quantity of milk and water is thrown, to be imbibed by the second; and so it is continued till the linen to be soured is sufficiently wet, and the liquor rises over the whole. The cloth is then kept down by covers filled with holes, and secured with a post fixed to the joist, that it may not rise. Some hours after the cloth has been in the sour, air-bubbles arise, a white scum is found on the surface, and an intestine motion goes on in the liquor. In warm weather it appears sooner, is stronger, and ends sooner, than in cold weather. Just before this fermentation, which lasts five or six days, is finished, at which time the scum falls down, the cloth should be taken out, rinsed, mill-washed, and delivered to the women to be washed with soap and water.

Washing with soap and water, is the fifth operation; and is performed thus. Two women are placed opposite at each tub, which is made of very thick staves, so that the edges, which slope inwards, are about four inches in thickness. A small vessel full of warm water is placed in each tub. The cloth is folded so that the selvage may be first rubbed with soap and warm water lengthways, till it is sufficiently impregnated with it. In this manner all the parcel is rubbed with soap, and afterwards carried to be bucked.

The lye now used has no soap in it, except what it gets from the cloth; and is equal in strength to the strongest formerly used, or rather stronger, because the cloth is now put in wet. From the former operation these lyes are gradually made stronger, till the cloth seems of an uniform white, nor any darkness or brown colour appears in its ground. After this the lye is more speedily weakened than it was increased; so that the last which the cloth gets, is weaker than any it got before.

But the management of sours is different; for they are used strongest at first, and decreased so in strength, that the last sour, considering the cloth is then always taken up wet, may be reckoned to contain three fourths of water.

From the bucking it goes to the watering, as formerly, observing only to overlap the selvages, and tie it down with cords, that it may not tear; then it returns to the four, milling, washing, bucking, and watering again. These operations succeed one another alternately till the cloth is whitened; at which time it is bleud, starched, and dried.

This is the method used in the whitening fine cloths. The following is the method used in the whitening of coarse cloths.

Having sorted the cloths, according to their quality, they are steeped in the same manner as the fine, rinsed, washed in the mill, and dried before boiling.

In this process, boiling supplies the place of bucking, as it takes less time, and consequently is thought cheapest. It is done in the following manner: 200 lb. casti b ashes, 100 lb. white Muscovy, and 30 lb. pearl-ashes, boiled in 105 Scots gallons of water for a quarter of an hour, as in the process for the fine cloth, makes the mother or first lye. The cloth-boiler is then to be filled two thirds full with water and mother-lye, about nine parts of the former to one of the latter; so that the lye used for boiling the coarse cloth, is about a third weaker than that used in bucking the fine. Such a quantity of cloth is put into the foregoing quantity of lye, when cold, as can be well covered by it. The lye is brought gradually to the boil, and kept boiling for two hours; the cloth being fixed down all the time, that it does not rise above the liquor. The cloth is then taken out, spread on the field, and watered, as mentioned before in the fine cloth.

As the salts of the lye are not exhausted by this boiling, the same is continued to be used all that day, adding, at each boiling, so much of the mother-lye as will bring it to the same strength as at first. The lye by boiling loses in quantity somewhat betwixt a third and a fourth; and they reckon that in strength it loses about a half, because they find in practice, that adding to it half its former strength in fresh lye, has the same effect on cloth. Therefore some fresh lye, containing a fourth part of the water, and the half of the strength of the first lye, makes the second boiler equal in strength to the first. To the third boiler they add somewhat more than the former proportion, and go on still increasing gradually to the fourth and fifth, which is as much as can be done in a day. The boiler is then cleaned, and next day they begin with fresh lye. These additions of fresh lye ought always to be made by the master-bleacher, as it requires judgment to bring succeeding lyes to the same strength as the first.

When the cloth comes to get the second boiling, the lye should be a little stronger, about a thirtieth part, and the deficiencies made up in the same proportion. For six or seven boilings, or fewer, if the cloth be thin, the lye is increased in this way, and then gradually diminished till the cloth is fit for souring. The whitest cloth ought always to be boiled first, that it may not be hurt by what goes before.

In this process, if the cloth cannot be got dry for boiling, business does not stop as in the fine; for after the

coarse



coarse has dreeped on racks made for the purpose, it is boiled, making the lye strong in proportion to the water in the cloth.

The common method of souring coarse linen is, to mix some warm water and bran in the vat, then put a layer of cloth, then more bran, water, and cloth; and so on, till the cave is full. The whole is tramped with mens feet, and fixed as in the former process. A thousand yards of cloth, yard-broad, require betwixt four and six pecks of bran. The cloth generally lies about three nights and two days in the sour. Others prepare their sour twenty-four hours before, by mixing the bran with warm water in a separate vessel; and before pouring it on the cloth, they dilute it with a sufficient quantity of water. After the cloth is taken from the sour, it ought to be well washed and rinsed again. It is then given to men to be well soaped on a table, and afterwards rubbed betwixt the rubbing-boards. When it comes from them, it should be well milled, and warm water poured on it all the time, if conveniency will allow of it. Two or three of these rubbings are sufficient, and the cloth very seldom requires more.

The lye, after the souring begins, is decreased in strength by degrees; and three boilings after that are commonly sufficient to finish the cloth. Afterwards it is starched, blued, dried, and bittled in a machine made for that purpose, which supplies the place of a calendar, and is preferred by many to it.

This method used in the bleaching of our coarse cloths, is very like that practised in Ireland for both fine and coarse. The only material difference is, that there the bleachers use no other ashes but the kelp or cashub. A lye is drawn from the former by cold water, which dissolves the salts, and not the sulphureous particles of the kelp ashes. This lye is used till the cloth is half whitened, and then they lay aside the kelp-lye for one made of cashub ashes.

In the preceding history of bleaching we may observe, that it naturally divides itself into several different branches or parts, all tending to give linen the degree of whiteness required. How they effectuate that comes next to be considered.

The general process of bleaching divides itself into these different parts. 1. Steeping and milling. 2. Bucking and boiling. 3. Alternate watering and drying. 4. Souring. 5. Rubbing with soap and warm water, starching, and bluing. We shall treat of these different parts in their order.

### S T E E P I N G.

GREEN linen, in the different changes which it has undergone before it arrives at that state, contracts a great foulness. This is chiefly communicated to it by the dressing composed of tallow and sowlens, which is a kind of slummary made of bran, flour, or oat-meal seeds. The first thing to be done in the bleachfield is to take off all that filth which is foreign to the flax, would blunt the future action of the salts, and might, in unskilful hands, be fixed in the cloth. This is the design of steeping.

To accomplish this end, the cloth is laid to steep in blood-warm water. A smaller degree of heat would not dissolve the dressing so soon; and the greater might coagulate and fix, in the body of the linen, those particles which we design to carry off. In a few hours the dressing made use in weaving is dissolved, mixed with the water; and, as it had acquired some degree of acidity, before application, it becomes a species of ferment. Each ferment promotes its own particular species of fermentation, or intestine motion; the putrid ferment sets in motion the putrefactive fermentation; the vinous ferment gives rise to the vinous fermentation; and the acid ferment to the acetous fermentation. That there is a real fermentation going on in steeping, one must be soon convinced, who attends to the air-bubbles which immediately begin to arise, to the scum which gathers on the surface, and to the intestine motion and swelling of the whole liquor. That it must be the acetous fermentation, appears from this, that the vegetable particles, already in part soured, must first undergo this process.

The effect of all fermentations is to set the liquor in motion; to raise in it a degree of heat; and to emit air-bubbles, which, by carrying up some of the light oleaginous particles along with them, produce a scum. But as the dressing is in small quantity in proportion to the water, these effects are gentle and slow. The acid salts are no sooner separated, by the acetous fermentation, from the absorbent earth, which made them not perceptible to the tongue in their former state, than they are united to the oily particles of the tallow, which likewise adhere superficially, dissolve them, and render them, in some degree, miscible with water. In this state they are soon washed off by the intestine motion of the liquor. The consequence of this operation is, that the cloth comes out freed in a great measure from its superficial dirt; and more pliant and soft than what it was.

Whenever this intestine motion is pretty much abated, and before the scum subsides, bleachers take out their cloth. The scum, when no more air-bubbles rise to support it, separates, and falls down; and would again communicate to the cloth great part of the filth. But a longer stay would be attended with a much greater disadvantage. The putrid follows close upon the acetous fermentation: When the latter ends, the former begins. Were this to take place, in any considerable degree, it would render the cloth black and tender. Bleachers cannot be too careful in this article.

The first question that arises to be determined on these principles is, What is the properest liquor for steeping cloth? Those used by bleachers are plain water; whiten-linen lye and water, equal parts; and rye-meal or bran mixed with water. They always make use of lye when they have it.

After steeping, the cloth is carried to the puttock-mill, to be freed of all its loose foulness. There can be nothing contrived so effectual to answer the purpose as this mill. Its motion is easy, regular, and safe. While it presses gently, it turns the cloth; which is continually washed with a stream of water. Care must be taken that no water be detained in the folds of the linen, otherwise that part may be damaged.

### BUCKING

## BUCKING AND BOILING.

THIS is the most important operation of the whole process, and deserves a thorough examination. Its design is to loosen, and carry off, by the help of alkaline lixives or lyes, that particular substance in cloth, which is the cause of its brown colour.

All ashes used in lye, the pearl excepted, ought to be well pounded, before they are put into the copper; for the Marcott and Cashub are very hard, and with some difficulty yield their salts. As these two last contain a very considerable proportion of a real sulphureous matter, which must in some degree tinge white cloth; and as this is dissolved much more by boiling, than by the inferior degrees of heat, while the salts may be as well extracted by the latter. The water should never be brought to boil, and should be continued for some time longer under that degree of heat. The pearl-ashes should never be put in till near the end, as they are easily dissolved in water.

If the salts were always of an equal strength, the same quantities would make a lye equally strong; but they are not. Salts of the same name differ very much from one another. The Muscovy ashes are turning weaker every day, as every bleacher must have observed, till at last they turn quite effete. A decoction from them when new, must differ very much from one when they have been long kept. Hence a necessity of some exact criterion to discover when lyes are of an equal strength. The taste cannot serve, as that is so variable, cannot be described to another, and is blunted by repeated trials. The proof-ball will serve the purpose of the bleachfield sufficiently; and, by discovering the specific gravity, will show the quantity of alkaline salts dissolved. But it cannot show the dangerous qualities of these salts; for the less caustic and less heavy this liquor is, the more dangerous and corrosive it may be for the cloth.

The third lye, which they draw from these materials by an infusion of cold water, in which the taste of lime is discoverable, appears plainly to be more dangerous than the first. The second lye, which they extract from the same ashes, and which is reckoned about a third in strength, when compared to the first, must be of the same nature; nor should it be used without an addition of pearl-ashes, which will correct it.

It is taken for a general rule, That the solution of any body in its menstruum is equally diffused through the whole liquor. The bleachers depending on this, use equal quantities of the top and bottom of their lye, when once clear and settled; taking it for granted, that there is an equal quantity of salts in equal quantities of the lye. But if there is not, the mistake may be of fatal consequence, as the lye may be in some places stronger than what the cloth can with safety bear. That general law of solution must have taken its rise from particular experiments, and not from reasoning. Whether a sufficient number of experiments have been tried to ascertain this point, and to establish an undoubted general rule, may be called in question.

“ But, says Dr Home, when I had discovered that

lime makes part of the dissolved substance, and reflected how long its grosser parts will continue suspended in water, there appeared stronger reasons for suspecting that this rule, though it may be pretty general, does not take place here; at least it is worth the pursuit of experiment.

“ I weighed at the bleachfield a piece of glass in some cold lye, after it had been boiled, stood for two days, and about the fourth part of it had been used. The glass weighed 3 drachms  $1\frac{1}{2}$  grains in the lye, and 3 drachms  $7\frac{1}{2}$  grains in river-water. The same glass weighed in the same lye, when almost all used, 2 grains less than it had done before. This shows, that the last of the lye contained a third more of the dissolved body; and, consequently, was a third stronger than the first of the lye.

“ As this might, perhaps, be owing to a continuation of the solution of the salts, I repeated the experiment in a different way.

“ I took from the surface some of the lye, after the salts were dissolved, and the liquor was become clear. At the same time I immersed a bottle, fixed to a long stick, so near the bottom, as not to raise the ashes there, and, by pulling out the cork by a string, filled the bottle full of the lye near the bottom. The glass weighed in river-water 3 drachms  $38\frac{1}{2}$  grains; in the lye taken from the surface 3 drachms  $34\frac{1}{2}$  grains; and in the lye taken from the bottom 3 drachms  $31\frac{1}{2}$  grains. This experiment shows, that the lye at the bottom was, in this case,  $\frac{1}{4}$  stronger than the lye at the surface.

“ At other times when I tried the same experiment, I found no difference in the specific gravity; and therefore, I leave it as a question yet doubtful, though deserving to be ascertained by those who have an opportunity of doing it. As the lye stands continually on the ashes, there can be no doubt but what is used last must be stronger than the first. I would, therefore, recommend, to general practice, the method used by Mr John Christie, who draws off the lye, after it has settled, into a second receptacle, and leaves the ashes behind. By this means it never can turn stronger; and he has it in his power to mix the top and bottom, which cannot be done so long as it stands on the ashes.”

Having considered the lye, let us next inquire how it acts. On this inquiry depends almost the whole theory of bleaching, as its action on cloth is, at least in this country, absolutely necessary. It is found by experiment, that one effect they have on cloth, is the diminishing of its weight; and that their whitening power is, generally, in proportion to their weakening power. Hence arises a probability, that these lyes act by removing somewhat from the cloth, and that the loss of this substance is the cause of whiteness. This appears yet plainer, when the bucking, which lasts from Saturday night to Monday morning is attended to.

There are various and different opinions with regard to the operation of these salts: That they act by altering the external texture of the cloth, or by separating the mucilaginous parts from the rest, or by extracting the oil which is laid up in the cells of the plant. The last is the general opinion, or rather conjecture, for none of them deserves any better name; but may we venture to affirm, that it is so without any better title to pre-eminence,

nence, than what the others have. Alkaline salts dissolve oils, therefore these salts dissolve the cellular oil of the cloth, is all the foundation which this theory has to rest on; too slight, when unsupported by experiment, to be relied on.

Dr Home endeavours to settle this question by the following experiments and observations.

“Wax, says he, is whitened by being exposed to the influence of the sun, air, and moisture. A discovery of the changes made on it by bleaching, may throw a light upon the question.

“Six drachms of wax were sliced down, exposed on a south window, Sept. 10. and watered. That day being clear and warm, bleached the wax more than all the following. It seemed to me to whiten quicker when it had no water thrown on it, than when it had. - Sept. 15. it was very white, and 1 drachm 3 grains lighter. 3½ drachms of this bleached wax, and as much of unbleached, taken from the same piece, were made into two candles of the same length and thickness, having cotton wicks of the same kind. The bleached candle burned one hour thirty-three minutes; the unbleached three minutes longer. The former run down four times, the latter never. The former had an obscure light and dull flame; the latter had a clear pleasant one, of a blue colour at the bottom. The former when burning seemed to have its wick thicker, and its flame nearer the wax, than the latter. The former was brittle, the latter not. It plainly appears from these facts, that the unbleached wax was more inflammable than the bleached; and that the latter had lost so much of an inflammable substance, as it had lost in weight; and consequently the substance lost in bleaching of wax is the oily part.

“As I had not an opportunity of repeating the former experiment, I do not look on it as entirely conclusive; for it is possible that some of the dust, flying about in the air, might have mixed with the bleached wax, and so have rendered it less inflammable. Nor do I think the analogical reasoning from wax to linen without objections. Let us try then if we cannot procure the substance extracted from the cloth, show it to the eye, and examine its different properties. The proper place to find it, is in a lye already used, and fully impregnated with these colouring particles.

“I got in the bleachfield some lye, which had been used all that day for boiling coarse linen, which was tolerably white, and had been twice boiled before. There could be no dressing remaining in these webs. No soap had ever touched that parcel; nor do they mix soap with the lye used for coarse cloth. Some of this impregnated lye was evaporated, and left a dark-coloured matter behind. This substance felt oily betwixt the fingers, but would not lather in water as soap does. It desagrated with nitre in fusion, and afforded a tincture to spirit of wine. By this experiment the salts seem to have an oily inflammable substance joined with them.

“Could we separate this colouring substance from these salts, and exhibit it by itself, so that it might become the object of experiment, the question would be soon decided. Here chymistry lends us its assistance. Whatever has a stronger affinity or attraction to the salts

with which it is joined, than this substance has, must set it at liberty, and make it visible. Acids attract alkaline salt from all other bodies; and therefore will serve our purpose.

“Into a quantity of the impregnated lye mentioned in the former experiment, I poured in oil of vitriol. Some bubbles of air arose, an intestine motion was to be perceived, and the liquor changed its colour from a dark to a turbid white. It curdled like a solution of soap, and a scum soon gathered on the surface, about half an inch in thickness, the deepness of the liquor not being above six inches. What was below was now pretty clear. A great deal of the same matter lay in the bottom; and I observed, that the substance on the surface was precipitated, and showed itself heavier than water, when the particles of air, attached to it in great plenty, were dispelled by heat. This substance was in colour darker than the cloth which had been boiled in it.

“I procured a considerable quantity of it by skimming it off. When I tried to mix it with water, it always fell to the bottom. When dried by the air, it diminished very much in its size, and turned as black as a coal. In this state it desagrated strongly with nitre in fusion; gave a strong tincture to spirit of wine; and when put on a red-hot iron, burnt very slowly, as if it contained a heavy ponderous oil; and left some earth behind.

“From the inflammability of this substance, its rejecting of water, and dissolving in spirit of wine, we discover its oleaginous nature; but from its great specific gravity we see that it differs very much from the expressed or cellular oil of vegetables; and yet more from their mucilage. That it dissolves in spirit of wine, is not a certain argument of its differing from expressed oils; because these, when joined to alkaline salts, and recovered again by acids, become soluble in spirit of wine. The quantity of earthy powder left behind after burning, shows that it contains many of the solid particles of the flax. The substance extracted from cloth by alkaline lyes appears then to be a composition of a heavy oil, and the solid earthy particles of the flax.

“In what manner these salts act so as to dissolve the oils, and detach the solid particles, is uncertain; but we see evidently how much cloth must be weakened by an improper use of them, as we find the solid particles themselves are separated.”

It is necessary that cloth should be dry before bucking, that the salts may enter into the body of the cloth along with the water; for they will not enter in such quantity, if it be wet; and by acting too powerfully on the external threads, may endanger them.

The degree of heat is a very material circumstance in this operation. As the action of the salts is always in proportion to the heat, it would appear more proper to begin with a boiling heat, by which a great deal of time and labour might be saved. The reason why this method is not followed, appears to be this. If any vegetable or vegetable substance is to be softened, and to have its juices extracted, it is found more proper to give it gentle degrees of heat at first, and to advance gradually, than to plunge it all at once in boiling water. This last degree of heat is so strong, that when applied at once to a vegetable, it hardens, instead of softening its texture. Dried

vegetables are immediately put into boiling water by cooks, that these substances may preserve their green colour, which is only to be done by hindering them from turning too soft. Boiling water has the same effect on animal substances; for if salt beef is put into it, the water is kept from getting at the salts, from the outside of the beef being hardened.

But when we consider, how much of an oily substance there is in the cloth, especially at first, which will for some time keep off the water, and how the twisting of the threads, and closeness of the texture, hinders the water from penetrating, we shall find, that if boiling water were put on it at once, the cloth might be liable, in several parts, to a dry heat, which would be much worse than a wet one. That the lyes have not access to all parts of the cloth, at first, appears plainly from this, that when it has lain, after the first bucking, till all the lyes are washed out, it is as black, in some parts, as when it was steeped. This must be owing to the discharge of the colouring particles from those places to which the lye has access, and to their remaining where it has not. It would seem adviseable, then, in the first bucking or two, when the cloth is foul, to use the lye considerably below the boiling point; that by this soaking or maceration, the foulness may be entirely discharged, and the cloth quite opened for the speedy reception of the boiling lye in the buckings which follow.

The lyes should likewise be weakest in the first buckings, because then they act only on the more external parts; whereas, when the cloth is more opened, and the field of action is increased, the active powers ought to be so too. For this reason they are at the strongest after some fourings.

The only thing that now remains to be considered, is, the management of the coarse cloth, where boiling is substituted in place of bucking. This species of linen cannot afford the time and labour necessary for the latter operation; and therefore they must undergo a shorter, and more active method. As the heat continues longer at the degree of boiling, the lyes used to the coarse cloth must be weaker than those used to the fine. There is not so much danger from heat in the coarse as in the fine cloth, because the former is of a more open texture, and will allow the lye to penetrate more speedily. In the closer kinds, however, the first application of the salts should be made without a boiling heat.

#### ALTERNATE WATERING AND DRYING.

AFTER the cloth has been bucked, it is carried out to the field, and frequently watered for the first six hours. For if during that time, when it is strongly impregnated with salts, it is allowed to dry, the salts approaching closer together, and, assisted by a greater degree of heat, increasing always in proportion to the dryness of the cloth, act with greater force, and destroy its very texture. After this time, dry spots are allowed to appear before it gets any water. In this state it profits most, as the latter part of the evaporation comes from the more internal parts of the cloth, and will carry away most from those parts. The bleaching of the wax, in a preceding

experiment, helps to confirm this; for it seemed to whiten most when the last particles of water were going off.

This continual evaporation from the surface of the cloth shows, that the design of the operation is to carry off somewhat remaining after the former process of bucking. This appears likewise from a fact known to all bleachers, that the upper side of cloth, where the evaporation is strongest, attains to a greater degree of whiteness than the under side. But it is placed beyond all doubt by experiment, which shews, that cloth turns much lighter by being exposed to the influence of the sun, air, and winds, even though the salts have been washed out of it.

What, then, is this substance? As we have discovered in the former section, that the whitening, in the operation of bucking, depends on the extracting or loosening the heavy oil, and solid particles of the flax; it appears highly probable, that the effects of watering, and exposition to the sun, air, and winds, are produced by the evaporation of the same substance, joined to the salts, with which composite body the cloth is impregnated when exposed on the field. That these salts are in a great measure carried off or destroyed, appears from the cloth's being allowed to dry without any danger, after the evaporation has gone on for some time. "If we can show," says Dr Home, that oils and salts, when joined together, are capable of being exhaled, in this manner, by the heat of the atmosphere, we shall reduce this question to a very great degree of certainty.

"Sept. 10. I exposed, in a south-west window, half an oz. of Castile soap, sliced down, and watered. Sept. 14. when well dried, it weighed but 3 dr. 6 gr. Sept. 22. it weighed 2 dr. 2 gr. Sept. 24. it weighed 1 dr. 50 gr. It then seemed a very little whiter; but was much more mucilaginous in its taste, and had no degree of saltiness, which it had before.

"It appears from this experiment, that soap is so volatile, when watered, and exposed to air not very warm, that it loses above the half its weight in fourteen days. The same must happen to the saponaceous substance, formed from the conjunction of the alkaline salts, heavy oil, and earthy particles of the flax. The whole design, then, of this operation, which, by way of pre-eminence, gets the name of *bleaching*, is to carry off, by the evaporation of water, whatever has been loosened by the former process of bucking.

"Against this doctrine there may be brought two objections, seemingly of great weight. It is a general opinion amongst bleachers, that linen whitens quicker in March and April, than in any other months: But as the evaporation cannot be so great at that time, as when the sun has a greater heat; hence the whitening of cloth is not in proportion to the degree of evaporation; and therefore the former cannot be owing to the latter. This objection vanishes, when we consider, that the cloth which comes first into the bleachfield, in the spring, is closely attended, having no other to interfere with it for some time; and, as it is the whitest, gets, in the after buckings, the first of the lye; while the second parcel is often bucked with what has been used to the first. Were the fact true, on which the objection is founded, this would

be.

be a sufficient answer to the objection. But it appears not to be true, from an observation of Mr John Christie, That cloth laid down in the beginning of June, and finished in September, takes generally less work, and undergoes fewer operations, than what is laid down in March, and finished in June.

“ The other objection is, That cloth dries much faster in windy weather than in calm sunshine; but it does not bleach so fast. This would seem to show, that the sun has some particular influence independent on evaporation. In answer to this objection, let it be considered, that it is not the evaporation from the surface, but from the more internal parts that is of benefit to the cloth. Now, this latter evaporation must be much stronger in sunshine than in windy weather, on account of the heat of the sun, which will make the cloth more open; while the coldness of windy weather must shut it up, so that the evaporation will all be from the surface. Clear sunshine, with a very little wind, is observed to be the best weather for bleaching; a convincing proof that this reasoning is just.

“ It would seem to follow as a corollary from this reasoning, that the number of waterings should in general be in proportion to the strength of the lye; for the stronger the lye is, the more there is to be evaporated; and the greater the danger, in case the cloth should be allowed to dry. But there is an exception to this general rule, arising from the consideration of another circumstance. It is observed, that cloth, when brown, dries sooner than when it becomes whiter, arising from the closeness and oiliness which it then has, not allowing the water a free passage. Perhaps that colour may retain a greater degree of heat, and in that way assist a very little. Cloth therefore, after the first buckings, must be more carefully watered than after the last.

“ It follows likewise from this reasoning, that the soil of the bleachfield should be gravelly or sandy, that the water may pass quickly through it, and that the heat may be increased by the reflection of the soil: for the success of this operation depends on the mutual action of heat and evaporation. It is likewise necessary that the water should be light, soft, and free from mud or dirt, which, not being able to rise along with the water, must remain behind. When there is much of this, it becomes necessary to rinse the cloth in water, and then give it a milking, to take out the dirt; else it would be fixed in the cloth by the following bucking, as it is not soluble by the lye.

“ This operation has more attributed to it by bleachers than it can justly claim. The cloth appears, even to the eye, to whiten under these alternate waterings and dryings; and these naturally get the honour of it, when it more properly belongs to the former operation. Here lies the fallacy. Alkaline salts give a very high colour to the decoctions, or infusion of vegetables. This is probably owing to the solution of the oleaginous colouring particles of the plant; which particles, being opened and separated by the salts, occupy a greater space, and give a deep colour to the liquor. The cloth participates of the liquor and colour. Hence bleachers always judge of the goodness of the bucking by the deepness of its

colour. The rule, in general, is good. I observe, that in those buckings which continue from the Saturday night to the Monday morning, the cloth has always the deepest colour. When that cloth has been exposed some hours to the influence of the air, these colouring particles, which are but loosely attached to it, are evaporated, and the linen appears of a brighter colour. This operation does no more than complete what the former had almost finished. If its own merit were thoroughly known, there would be no occasion to attribute that of another operation to it. Thread, and open cloths, such as diaper, may be reduced to a great degree of whiteness, after one bucking, by it alone. No cloth, as would appear, can attain to a bright whiteness without it.

“ Since the only advantage of watering is the removal of the salts, and what they have dissolved, might we not effectuate this by some cheaper, and more certain method? For it occupies many hands; and must depend altogether on the uncertainty of the weather; so that, in the beginning of the season, the bleacher is often obliged to repeat his buckings without bleaching. We might take out the alkaline salts by acids; but then the other substance would be left alone in the cloth, nor would any washing be able to remove it. Mill-washing appears a more probable method of taking out both salts and oils; and it would seem that this might, in a great measure, supply the place of watering; but upon trial it does not succeed. Two parcels of linen were managed equally in every other respect, except in this, that one was watered; and exposed to the influence of the air, and the other was only mill-washed. This method was followed until they were fit for souring; The cloth which had been mill-washed, had a remarkable green colour, and did not recover the bright colour of the pieces managed in the common way, until it had been treated like them for a fortnight. The green colour was certainly owing to a precipitation of the sulphureous particles, with which the lye is impregnated, upon the surface of the cloth; owing to the salts being washed off more speedily than the sulphur, to which they are united in the lye. The attachment betwixt these two bodies we know is very loose, and the separation easily made. Evaporation then alone is sufficient to carry off these sulphureous particles.”

#### SOURING.

It is well known to all chymists, that alkaline salts are convertible, by different methods, into absorbent earths. Frequent solution in water, and evaporation of it again, is one of these. This transmutation then of these salts, which are not volatilised or washed away, must be continually going on in the cloth under these alternate waterings and dryings of the former process; not much indeed after the first two or three buckings; because the salts, not having entered deep into the cloth, are easily washed off, or evaporated. But when they penetrate into the very composition of the last and minutest fibres, of which the first vessels are made, they find greater difficulty of escaping again, and must be more subject to this transmutation. But if we consider the  
bleaching.

bleaching ashes as a composition of lime and alkaline salts, we must discover a fresh fund for the deposition of this absorbent earth. The common caustic, a composition of this very kind, soon converts itself, if exposed to the open air, into a harmless earthy powder.

Frequent buckings and bleachings load the cloth with th's substance. It becomes then necessary to take it out. No washing can do that, because earth is not soluble in water. Nothing but acids can remove it. These are attracted by the absorbent earth, join themselves to it, and compose a kind of neutral imperfect salt, which is soluble in water; and therefore easily washed out of the cloth. The acid liquors commonly used are butter-milk, which is reckoned the best, sour milk, infusions of bran, rye-meal, &c. kept for some days till they sour. Sour whey is thought to give the cloth a yellow colour.

The linen ought to be dried before it is put in the sour, that the acid particles may penetrate, along with the watery, through the whole. A few hours after it has been there, air-bubbles arise, the liquor swells, and a thick scum is formed; manifest signs of a fermentation. The following experiment, says Dr Home, shews the degree of heat which attends it.

"May 25. I put a thermometer of Fahrenheit's into some butter-milk, of which the bleachers were composing their sours, and which stood in a vat adjoining to another, where the milk was the same, and the souring process had been going on for two days. After the thermometer had been twenty minutes in the butter-milk, the mercury stood at 64 degrees. In the souring vat it rose to 68 degrees. An increase of 4 degrees shows a pretty brisk intestine motion.

"To what are all these effects owing? To the acetous fermentation going on in those vegetable liquors, whose acids, extricating themselves, produce heat, intestine motion, and air-bubbles. As the change is slow, the process takes five or six days before it is finished. During this time the acid particles are continually uniting themselves to the absorbent earth in the cloth. That this fermentation goes on in the liquor alone, appears from this consideration, that the same effects, *viz.* air-bubbles, and scum, are to be seen in the butter-milk alone. The only effect then it has is, by the small degree of heat, and intestine motion, which attend it, to assist the junction of the acid and absorbent particles. We shall presently see, that this process may be carried on, to as great advantage, without any fermentation; and therefore it appears not absolutely necessary.

"When these absorbent particles are fully saturated, the remaining acids may unite with, and have some small effect in extracting the colouring particles. This appears from the two following experiments.

"Sept. 20. A piece of cloth which had been steeped, weighing  $41\frac{1}{2}$  gr. was put into a half-pound of butter-milk, whigged, and well soured, by a mixture of water, and by boiling. Sept. 24. When taken out, and washed in water, it appeared a very little whiter. The mineral acids, as will appear afterwards, whiten cloth, even though they are very much diluted.

"Just before the acetous fermentation is finished, the cloth should be taken out; otherwise the scum will fall

down, and lodge in the cloth, and the putrefaction which then begins will weaken it. This appears from the following experiment.

"Sep. 16. A piece of cloth, weighing 42. gr. was laid in butter-milk unwhigged. Novem. 15. The milk had a putrid smell. The cloth was a little whiter, but very tender; and weighed, when well washed in warm water and dried, 40 gr."

All the sours made of bran, rye-meal, &c. ought to be prepared before use; for by this means so much time will be saved. Besides, when the water is poured upon the cloth, and bran, as is done in the management of coarse cloth, the linen is not in a better situation than if it had been taken up wet from the field; and by this means the acid particles cannot penetrate so deep. Again, this method of mixing the bran with the cloth, may be attended with yet worse consequences. All vegetable substances, when much pressed, fall into the putrescent, and not the acetous fermentation. This often happens to the bran pressed betwixt the different layers on the linen, which must weaken the cloth. Hence, all sours should be prepared before the cloth is steeped in them; and none of the bran or meal should be mixed with the cloth.

The sours are used strongest at first, and gradually weakened till the cloth has attained to its whiteness. In the first sourings, there is more of the earthy matter in the cloth, from the many buckings it has undergone, than what there can be afterwards. As the quantity of this matter decreases, so should the strength of the sour. There is not, however, the least danger, at any time, from too strong a sour.

What is most wanted in this operation is a more expeditious and cheaper method of obtaining the same end. As it takes five or six days, it retards the whitening of the cloth considerably; and as bleachers are obliged to send for milk to a great distance, it becomes very dear. This last consideration makes them keep it so long, that, when used, it can have no good effect; perhaps it may have a bad one.

There is one consideration that may lead us to shorten the time. It is observed, that the souring process is sooner finished in warm than in cold weather. Heat quickens the fermentation, by aiding the intestine motion. The vats therefore should not be buried in the ground, as they always are, which must keep them cold; there should rather be pipes along the walls of the room, to give it that degree of heat, which, on trial, may be found to answer best. There are few days in summer so hot as is necessary; and the beginning and end of the season is by much too cold. That this is no ideal scheme, the following fact is a sufficient proof. There are two vats in Salton bleachfield, adjoining to a partition-wall, at the back of which there is a kitchen-fire. In these vats the souring process is finished in three days, whereas it lasts five or six days in the others placed round the same room.

This improvement, though it shortens the time of souring a very little, yet is no remedy against the scarcity and dearth of milk sours. Such a liquor as would serve our purpose, must be found either among the vegetable

table acids, which have no further fermentation to undergo, or among the mineral acids. The former are a large class, and contain within themselves many different species; such as the acid juice of several plants, vinegars made of fermented liquors, and acid salts, called *tartars*. But there is one objection against these vegetable acids: They all contain, along with the acid, a great quantity of oily particles, which would not fail to discolour the cloth. Besides, the demand of the bleachfields would raise their price too high.

The mineral acids have neither of these objections. They are exceedingly cheap, and contain no oil. "I will freely own, says Dr Home, that at first I had no great opinion of success from the mineral, from two reasons; their want of all fermentation, which I then looked on as necessary; and their extreme corrosiveness. But the experience of two different summers, in two different bleachfields, has convinced me, that they will answer all the purposes of the milk and bran sours; nay, in several respects, be much preferable to them. I have seen many pieces of fine cloth, which had no other sours but those of vitriol, and were as white and strong as those bleached in the common way. I have cut several webs through the middle, and bleached one half with milk, and the other with vitriol; gave both the same number of operations, and the latter were as white and strong as the former."

The method in which it has been hitherto used is this. The proportion of the oil of vitriol to the water, with which it is diluted, is half an ounce, or at most three quarters, to a gallon of water. As the milk-sours are diminished in strength, so ought the vitriol-sours. The whole quantity of the oil of vitriol to be used, may be first mixed with a small quantity of water, then added to the whole quantity of water, and well mixed together. The water should be milk-warm; by which means the acid particles will penetrate further, and operate sooner. The cloth should then be put dry into the liquor.

It is observed, that this sour performs its task much sooner than those of milk and bran; so that Mr John Chrystie, in making the trial, used to lay the milk-sours twenty-four hours before the vitriol. Five hours will do as much with this sour, as five days with the common sort. But the cloth can receive no harm in allowing it to remain for some days in the sour; but rather, on the contrary, an advantage. The cloth is then taken out, well rinsed, and mill-washed in the ordinary way.

The liquor, while the cloth lies in this sour, is less acid the second day than the first, less the third than the second, and so diminishes by degrees. At first it is clear, but by degrees a mucilaginous substance is observed to float in it, when put into a glass. This foulness increases every day. This substance, extracted by the acid, is the same with what is extracted by the alkaline salts, and blunts the acidity of the former, as it does the alkalescency of the latter. Hence the liquor loses by degrees its acidity. But as the acid salts do not unite so equally with oily substances as the alkaline do, the liquor is not so uniformly tinged in the former as in the latter case, and the mucous substance presents itself floating in it.

It is observed, that, in the first souring, which is the strongest, the liquor, which was a pretty strong acid before the cloth was put in, immediately afterwards becomes quite vapid; a proof how very soon it performs its task. But in the following operations, as the linen advances in whiteness, the acidity continues much longer; so that in the last operations the liquor loses very little of its acidity. This happens although the first buckings, after the first sourings, are increased in strength, while the sours are diminished. There are two causes to which this is owing. The texture of the cloth is now so opened, that although the lyes are strong, the alkaline salts and absorbent earth are easily washed out; and the oily particles are, in a great measure, removed which help to blunt the acidity of the liquor.

Two objections are made against the use of vitriol-sours. One is, that the process of souring with milk is performed by a fermentation; and, as there is no fermentation in the vitriol-sours, they cannot serve the purpose so well: The other, that they may hurt the texture of the cloth. The answer to the former objection is very short; that the vitriol-sours operate successfully without a fermentation, as experience shews; and therefore in them a fermentation is not necessary.

As to the latter objection, that oil of vitriol, being a very corrosive body, may hurt the cloth; that will vanish likewise, when it is considered how much the vitriol is diluted with water, that the liquor is not stronger than vinegar, and that it may be safely taken into the human body.

That it may be used with safety, much stronger than what is necessary in the bleachfield, appears from the following experiment with regard to the stamping of linen. After the linen is boiled in a lye of ashes, it is bleached for some time. After this, in order to make it receive the colour, it is steeped in a sour of water and oil of vitriol, about fifteen times stronger than that made use of in the bleachfield; for, to 100 gallons of water are added two and a half of oil of vitriol. Into this quantity of liquor, made so warm as the hand can just be held in it, is put seven pieces of 28 yards each. The linen remains in it about two hours, and comes out remarkably whiter. The fine cloth often undergoes this operation twice. Nor is there any danger if the oil of vitriol is well mixed with the water. But if the two are not well mixed together, and the oil of vitriol remains in some parts undiluted, the cloth is corroded into holes.

Let us now take a view of the advantages which the vitriol-sours must have over the milk. The latter is full of oily particles, some of which must be left in the cloth: But the case is worse when the scum is allowed to precipitate upon the cloth. The former is liable to neither of these objections.

The common sours hasten very fast to corruption; and if, from want of proper care, they ever arrive at that state, must damage the cloth very much. As the milk is kept very long, it is often corrupted before it is used; and, without acting as a sour, has all the bad effects of putrefaction. The vitriol-sours are not subject to putrefaction.

The milk takes five days to perform its task, but the vitriol-

vitriol-sours do it in as many hours; nay, perhaps as many minutes. Their junction with the absorbent particles in the cloth must be immediate, whenever these acid particles enter with the water. An unanswerable proof that the fact is so, arises from the circumstances which happen when the cloth is first steeped in the vitriol-sour; the cloth has no sooner imbibed the acid liquor than it loses all acidity, and becomes immediately vapid. This effect of vitriol-sours must be of great advantage in the bleachfield, as the bleachers are at present hindered from enjoying the season by the tediousness of the souring process. The whole round of operations takes seven days; to answer which they must have seven parcels, which are often mixing together, and causing mistakes. As three days, at most, will be sufficient for all the operations when vitriol-sours are used, there will be no more than three parcels. The cloth will be kept a shorter time in the bleachfield, and arrive sooner at market.

The milk-sours are very dear, and often difficult to be got; but the vitriol are cheap, may be easily procured, and at any time.

There is yet another advantage in the use of vitriol, and that is its power of whitening cloth. Even in this diluted state, its whitening power is very considerable. We have already seen, that it removes the same colouring particles, which the alkaline lyes do. What of it then remains, after the alkaline and absorbent particles are neutralized in the cloth, must act on these colouring particles, and help to whiten the cloth. That this is really the case, appears from the following fact. Mr Chrystie being obliged to chuse twenty of the whitest pieces out of a hundred, five of the twenty were taken out of seven pieces which were bleached with vitriol.

From both experience and reason, it appears, that it would be for the advantage of our linen-manufacture to use vitriol in place of milk-sours.

#### HAND-RUBBING with Soap and Warm Water, RUBBING-BOARDS, STARCHING, and BLUING.

AFTER the cloth comes from the souring, it should be well washed in the washing-mill, to take off all the acid particles which adhere to its surface. All acids decompose soap, by separating the alkaline salts and oily parts from one another. Were this to happen on the surface of the cloth, the oil would remain; nor would the washing-mill afterwards be able to carry it off.

From the washing-mill the fine cloth is carried to be rubbed by womens hands, with soap and water. As the liquors, which are generally employed for souring, are impregnated with oily particles, many of these must lodge in the cloth, and remain, notwithstanding the preceding milling. It is probable, that all the heavy oils are not evaporated by bleaching. Hence it becomes necessary to apply soap and warm water, which unite with, dissolve, and carry them off. It is observed, that if the cloth, when it is pretty white, gets too much soap, the following bleaching is apt to make it yellow; on that account they often wring out the soap.

It is a matter worth inquiring into, whether hard or soft soap is best for cloth. Most bleachers agree, that

hard soap is apt to leave a yellowness in the cloth. It is said, that the use of hard soap is dischaged in Holland. As there must be a considerable quantity of sea-salt in this kind, which is not in the soft, and as this salt appears prejudicial to cloth, the soft soap ought to be preferred.

The management of the coarse cloth is very different, in this operation, from fine. Instead of being rubbed with hands, which would be too expensive, it is laid on a table, run over with soap, and then put betwixt the rubbing-boards, which have ridges and grooves from one side to another, like teeth. These boards have small ledges to keep in the soap and water, which saves the cloth. They are moved by hands, or a water-wheel, which is more equal and cheaper. The cloth is drawn, by degrees, through the boards, by men who attend; or, which is more equal and cheaper, the same water-wheel moves two rollers, with ridge and groove, so that the former enters the latter, and, by a gentle motion round their own axis, pull the cloth gradually through the boards.

This mill was invented in Ireland about thirty years ago. The Irish bleachers use it for their fine, as well as coarse cloath. These rubbing-boards were dischaged, some years ago, in Ireland, by the Trustees for the manufactures of that country, convinced from long experience of their bad effects. But as proper care was not taken to instruct the bleachers by degrees in a safer method, they continued in the old, made a party, and kept possession of the rubbing-boards. There were considerable improvements made in them in this country; such as the addition of the ledges, to keep the cloth moist; and of the rollers, which pull the cloth more gradually than mens hands. These improvements were first made in Salton bleachfield.

The objections against these rubbing-boards, are unanswerable. By rubbing on such an unequal surface, the solid fibrous part of the cloth is wore; by which means it is much thinned, and in a great measure weakened before it comes to the market. As a proof of this, if the water which comes from the cloth in the rubbing-boards be examined, it will be found full of cottony fibrous matter. These boards give the cloth a cottony surface, so that it does not keep long clean. Again, they flatten the threads, and take away all that roundness and firmness, which is the distinguishing property of cloth bleached in the Dutch method.

For these reasons they must be very prejudicial to fine cloth, and should never be used in bleaching it. As they seem to be, in some measure, necessary to lessen the expence of bleaching coarse linen, they ought never to be used above twice, or thrice at most. They might be rendered much more safe, by lining their insides with some soft elastic substance, that will not wear the cloth so much as the wooden teeth do. Mr Chrystie at Perth has lined his boards with short hair for some years past, and finds that it answers very well.

After the coarse linen has undergone a rubbing, it should be immediately milled for an hour, and warm water poured now and then on it to make it lather. This milling has very good effects; for it cleans the cloth of all



all the dirt and filth which the rubbing-boards have loosened, and which, at the next boiling, would discolour the cloth. Besides, it is observed, that it makes the cloth less cottony, and more firm, than when whitened by rubbing alone.

The last operation is that of starching and bluing. It often happens, that the cloth, when exposed to the weather to be dried after this operation, gets rain; which undoes all again, and forces the bleacher to a new expence. To remedy this inconvenience, Mr Chrystie, some years ago, invented the dry-house, where the cloth may be dried, after this operation, in any weather. This invention meets with universal approbation.

#### A METHOD OF BLEACHING SAFELY WITH LIME.

Dr Home has found by repeated trials, that alkaline salts added to lime, diminish its power of weakening and corroding cloth; and that in proportion to the quantity of these salts added to the lime. This composition, as it is not so dangerous as lime alone, so it is not so expeditious in whitening. When equal parts of each are used, the whitening power is strong, and the weakening power not very considerable; so that they might be used with safety to bleach cloth, in the proportion of one part of lime to four of pure alkaline salts. This fully accounts for an observation made by all bleachers, That the bleaching salts, when mixed together, operate safer and better than when used separately. For the corrosive power of the Muscovy, Marcott, and Cashub ashes is corrected by the pearl ashes, and the whitening quality of the latter is increased by that of the former.

There is not a more corroding substance, with regard to animals, than alkaline salts and lime joined together, especially when fused in the fire. This is the composition of the common caustic. But lime, and lime-water alone, preserve animal substances in a sound entire state. It appears then surprising, that salts and lime should be found so little destructive of cloth, when lime, or lime-water alone, destroys it so remarkably. But that this is a fact, is made evident by many experiments, and has been practised both with success and safety, by a bleacher who gives the following account of his method of bleaching with lime.

“First, says he, I steep the cloth in warm water for twenty-four hours; then clean it in a washing mill, of all the dressing, or sowing, as the vulgar term it. Afterwards I buck the cloth with cow-dung and water, and bleach it with this for three days; then clean it again, and boil it with a lye made of Cashub ashes. A pound to each piece of 18 or 20 yards long is sufficient. This I do twice, as no lime ought to be given to cloth before it is a full third whitened; as it by no means advances the whitening of the cloth, but, on the contrary, protracts it: For, instead of loosening the oil and dirt in the cloth, when brown, it rather fixes them; just as when fine cloth is bucked with over-warm lyes in the first buckings. Lime is by no means fit for discharging the oil in the cloth, but for cleaning it of the dead part, commonly called *sprat*. The cloth, being cleaned, is

laid upon a dreeper. It must not be drier before bucking with lime, otherwise it will take in more than can be got out again before the next application: For as I have observed already, that lime is only fit for discharging the dead part, bucking thus wet make it rest on the outside of the cloth. I take a lippy of the finest and richest powdered lime that can be got, of the brightest white colour, as poor lime does more hurt than good, to thirty pieces of the above length; and make a cold lye of it, by stirring and pouring water off the lime, until all be dissolved, but the dross, which is thrown away: Then I add a little soap, which makes the lye have the nearest resemblance to milk that breaks in boiling, of any thing I can think of: For this soap blunts the hotness of the lime. Then I take the cloth, and dip it in the lime-lye, and that moment out again, and lay it on a dreeper until it be bucked; then put it on the field, watering it carefully; for if allowed to dry, it is much damaged. This is done always in the morning: as it cannot be done at night, in regard of the hot quality of the lime, which soon heats the cloth, and tenders it. If a hot sunshine follows, it has great effect; for lime is just like all other materials for bleaching, that have more or less effect according as the weather is good or bad. I take it up the second day after bucking, and give it a little milling, or hand-bleaching, or bitting, commonly called *knocking*; and lay it on the field again, watering it carefully as before. The effect is more visible the second than the first day. As all cloth when limed should have a great deal of work, otherwise more than half the effect is lost; and not only that, but a great deal of labour and pains is requisite to take the lime out of the cloth again; it must never be exposed on the Sabbath day, but carefully kept wet always while used in this way. Thus bucking for three or four times at most, is sufficient for any cloth, except that made of flax pulled either over-green, or which grows in a drougthy season, or perhaps not so well heckled as it should be. This sort occasions great trouble and expence to the bleacher. But the most effectual and expeditious way I ever found for this kind, was, after boiling, to take a little of the warm lye, and mix a very small quantity of lime with it, and draw the cloth through that as hot as possible, and put it on the field directly, watering it carefully. This will clean it of the *sprat* surprisingly. Then I boil it with pearl ashes, and give it the last boil with soap.

“There are innumerable mistakes in the use of lime committed by the vulgar, who are ignorant of its quality and effects. They know only this in general, that it is a thing which whitens cloth cheap, and is easy purchased; therefore they will use it. Some of them begin whitening of their cloth with it, which I have already observed to be wrong, and given reasons for it, and continue it until the cloth is bleached; give it a boil or two at most, and then wash it up while the gross body of the lime is in the substance of the cloth. This makes limed cloth easily distinguishable from unlimed, as the former has a yellowish colour, and is full of a powder. Besides, as lime is of a very hot corroding nature, it must by degrees weaken the cloth. The bad effects of this substance do not end here. When the cloth is put on board, it contracts

tracts a dampness, which not only makes it yellow, and lose any thing of colour it has, but directly rots it. And although it should escape this, which it is possible it may, by a quick and speedy passage; yet whenever it is put in any warehouse, it will meet with moisture there, especially if the winter-season should come on before it is disposed or made use of. These I take to be the prin-

cipal reasons for so much complaint in bleaching with this material."

The whole art and safety in using the lime, according to this method, depends on the junction of the alkaline salts, during the bucking, to the particles of lime which were on the surface of the cloth.

## B L E

**BLEAK**, the English name of the fish called cyprinus. See **CYPRINUS**.

**BLECHINGLY**, a borough-town of Surry, about twenty miles south of London; W. long. 20', and N. lat. 51° 20'.

**BLECHNUM**, in botany, a genus of the cryptogamia filices. The seeds and parts of fructification of this fern lie in small lines under the plaits of the leaves. The species are two, viz. the occidentale, a native of America; and the orientale, a native of China.

**BLEEDING**, in surgery. See **SURGERY**.

**BLEEDING at the nose**. See **HEMORRHAGE**, and **MEDICINE**.

**BLEEDING** is also used for the drawing out the sap of plants, otherwise called tapping. See **TAPPING**.

**BLEKING**, the most south-easterly province of Sweden, having the Baltic on the south, Smaland on the north, and the province of Schonen on the west.

**BLEMISH**, a term in hunting, when the hounds or beagles finding where the chace has been, make a profuse to enter, but return.

**BLEMYES**, or **BLEMMYES**, a fabulous people of Ethiopia, said to have had no heads; their eyes, mouth, &c. being situated in their breasts.

**BLENCH** or **BLANCH**. See **BLANCH**.

**BLEND**, or **BLENDE**, a mineral substance resembling lead-ore, but containing very little of that metal.

**BLEND-WATER**, called also *morehough*, a distemper incident to black cattle, comes either from the blood, from the yellows, or from the change of ground.

In order to cure it, take bole armoniac, and as much charcoal dust as will fill an egg-shell, a good quantity of the inner bark of an oak, dried and pounded together to a powder, and give it to the beast in a quart of new milk and a pint of earning.

**BLENHEIM**, a village of Swabia in Germany, situated on the west side of the Danube, three miles north-east of Hockstet, and twenty-seven miles north-east of Ulm; E. long. 10° 25', N. lat. 48° 40'.

**BLENNIUS**, in ichthyology, a genus of fishes belonging to the order of jugulares; the characters of which are these: The head slants or declines to one side; there are six rays in the membrane of the gills; the body tapers toward the tail; the belly-fins have only two blunt bones; and the tail-fin is distinct. The species are 13, viz. 1. The galeria, with a transverse membranous crest upon the head. It is found in the European seas. 2. The cristatus, with a longitudinal bristly crest betwixt the eyes. 3. The cornutus, with a simple ray above the eyes, and a single back-fin. The

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above two are natives of the Indies. 4. The ocellaris, with a furrow betwixt the eyes, and a large spot on the back-fin. 5. The gattorugine, with small palmated fins about the eye-brows and neck. It is about seven or eight inches long. These two last are found in the European seas. 6. The superciliofus, with small fins about the eye-brows, and a curved lateral line. It is a native of India. 7. The phycis, with a kind of crested nostrils, a cirrus or beard on the under lip, and a double fin on the back. It has seven rays in the gill-membrane; the anus is surrounded with a black ring; and the tail is roundish. 8. The pholis has a smooth head, a curve line upon the sides, and the upper jaw is larger than the under one. The two last are found in the Mediterranean sea. 9. The gunnellus has 10 black spots on the back-fin. It is found in the Atlantic Ocean. 10. The mustelaris has three rays on the fore-part of the back-fin. It is a native of India. 11. The viviparus has two tentacula at the mouth. 12. The lumpenus has several dusky-coloured areolæ running across its body. The two last are found in the European seas. 13. The ranius, with six divisions in the belly-fins. It is found in the lakes of Sweden. It is remarkable, that when this fish appears in the lake, all the other fishes retire; and what is worse, it is not fit for eating.

**BLEYME**, an inflammation arising from bruised blood between a horse's sole and the bone of the foot, towards the heel. Of these there are three sorts: The first being bred in spoiled wrinkled feet, with narrow heels, are usually seated in the inward or weakest quarter. In this case the hoof must be pared, and the matter let out; then let oil *de merveille* be poured in, and the hoof be charged with a remolade of foot and turpentine.

The second sort, besides the usual symptoms of the first, infects the gristle, and must be extirpated, as in the cure of a quitter bone, giving the horse, every day, moistened bran, with two ounces of liver of antimony, to divert the course of the humours, and purify the blood.

The third sort of bleymes, is occasioned by small stones and gravel between the shoe and the sole. In this case the foot must be pared, and the matter, if any, let out: If there be no matter, then the bruised sole must be taken out; but if there be matter, the sore must be dressed like the prick of a nail.

**BLIGHT**, in husbandry, a disease incident to plants, which affects them variously, the whole plant sometimes perishing by it, and sometimes only the leaves and

and blossoms, which will be scorched and shrivelled up, the rest remaining green and flourishing.

Some have supposed that blights are usually produced by an easterly wind, which brings vast quantities of insects eggs along with it, from some distant place, that, being lodged upon the surface of the leaves and flowers of fruit-trees, cause them to shrivel up and perish.

To cure this distemper, they advise the burning of wet litter on the windward side of the plants, that the smoke thereof may be carried to them by the wind, which they suppose will stifle and destroy the insects, and thereby cure the distemper.

Others direct the use of tobacco-dust, or to wash the trees with water wherein tobacco-stalks have been infused for twelve hours; which they say will destroy those insects, and recover the plants.

Pepper-dust scattered over the blossoms of fruit-trees, &c. has been recommended as very useful in this case; and there are some that advise the pulling off the leaves that are distempered.

The true cause of blights seems to be continued dry easterly winds for several days together, without the intervention of showers, or any morning dew, by which the perspiration in the tender blossom is stopped; and if it so happens, that there is a long continuance of the same weather, it equally affects the tender leaves, whereby their colour is changed, and they wither and decay.

The best remedy for this distemper, is gently to wash and sprinkle over the tree, &c. from time to time with common water; and if the young shoots seem to be much infected, let them be washed with a woollen cloth, so as to clear them, if possible, from this glutinous matter, that their respiration and perspiration may not be obstructed. This operation ought to be performed early in the day, that the moisture may be exhale before the cold of the night comes on: Nor should it be done when the sun shines very hot.

Another cause of blights in the spring, is sharp hoary frosts, which are often succeeded by hot sunshine in the day time: This is the most sudden and certain destroyer of the fruits that is known.

**BLIGHTED corn.** See **SMUT.**

**BLIND.** See **BLINDNESS.**

**Pore-BLIND,** or **pur-BLIND.** A person who is very short-sighted is said to be *pur-blind*.

**Moon-BLIND,** denotes horses that lose their sight at certain times of the moon.

**BLIND** is also used figuratively, for things without apertures; Thus we say, *a blind wall, a blind alembic, &c.*

**BLIND,** among traders, a kind of false light which they have in their warehouses and shops, to prevent too great a light from diminishing the lustre of their stuffs.

**BLIND, BLINDE, or BLEND.** See **BLEND.**

**BLINDS,** or **BLINDES,** in the art of war, a sort of defence commonly made of ozers, or branches interwoven, and laid across between two rows of stakes, about the height of a man, and four or five feet asunder, used particularly at the heads of trenches, when they are extended in front towards the glacis; serving to shelter the workmen, and prevent their being overlooked by the enemy.

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**BLINDNESS,** a total privation of sight, arising from an obstruction of the functions of the organs of sight, or from an intire deprivation of them. See **MEDICINE, Of the gutta serena, &c.**

**BLINDNESS,** in farriery. When a horse becomes blind, it may be thus discerned: His walk or step is always uncertain and unequal, so that he does not set down his feet boldly when led in one's hand: But if the same horse be mounted by an expert horseman, and if he be a beast of metal, then the fear of the spurs will make him go resolutely and freely; so that his blindness can hardly be perceived.

**BLISTER,** in medicine, a thin bladder containing a watery humour, whether occasioned by burns, and the like accidents, or by vesicatories applied to different parts of the body for that purpose.

Cantharides, or Spanish flies, applied in the form of a plaster, are chiefly used with this intention. See **CANTHARIDES.**

**BLITE,** in botany. See **BLITUM.**

**BLITH,** a market-town in Nottinghamshire, about 18 miles north-west of Newark; in 1° W. long. and 53° 25' N. lat.

**BLITUM,** in botany, a genus of the monandria digynia class. The calix consists of three segments; there are no petals; and the seed, which is single, is inclosed in the calix, which becomes a kind of berry. The species are two; *viz.* the capitatum, a native of Tyrol; and the virgatum, a native of Tartary and Spain.

**BLOATING,** among physicians. See **EMPHYSEMA.**

**BLOCK,** a large mass of wood, serving to work or cut things on.

**BLOCKS,** on ship-board, is the usual name of what we call pulleys at land. They are thick pieces of wood, some with three, four, or five shivers in them, through which all the running ropes run. Blocks, whether single or double, are distinguished and called by the names of the ropes they carry, and the uses they serve for.

Double blocks are used when there is occasion for much strength, because they will purchase with more ease than single blocks, though much slower.

Block and block is a phrase signifying that two blocks meet, in hauling any tackle, or halliard, having such blocks belonging to them.

Fish-block is hung in at a notch at the end of the davit. It serves to hale up the flocks of the anchor at the ship's prow.

Snatch-block is a great block with a shiver in it, and a notch cut through one of its cheeks, for the more ready receiving of any rope; as by this notch the middle-part of a rope may be reeved into the block, without passing it endwise. It is commonly fastened with a strap about the main-mast, close to the upper deck, and is chiefly used for the fall of the winding tackle, which is reeved into this block, and then brought to the capstan.

**BLOCK,** among bowlers, denotes the small bowl used as a mark.

**Block,** in falconry, the perch upon which they place the hawk. It ought to be covered with cloth.

**FLOCKADE,** in the art of war, the blocking up a place,

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place, by posting troops at all the avenues leading to it, to keep supplies of men and provisions from getting into it; and by these means proposing to starve it out, without making any regular attacks.

To raise a blockade, is to force the troops that keep the place blocked up, from their posts.

**BLOIS**, a beautiful city of Orleans, about 30 miles south-west of Orleans; situated on the north shore of the river Loire, in one of the finest countries in France; in 1° 20' E. long. and 47° 35' N. lat.

**BLOMARY**, or **BLOOMARY**, in metallurgy, the first forge through which iron passes, after it is melted out of the ore.

**BLONIC**, a town of Poland, about 20 miles west of Warsaw; in 20° 30' E. long. and 52° N. lat.

**BLOOD**, a well known fluid, which circulates through the arteries, veins, &c. of animal-bodies, and nourishes all their parts.

Blood is composed of a thin watery liquor called *serum*, and a thick red part called *crassamentum*, which, when viewed by the microscope, appears to consist of red globules of a certain determined magnitude. These globules are generally believed to be of the same magnitude in all animals that have red blood.

As blood is originally derived from our aliment, it must consist of the same principles, and consequently abound with salts and oils. The salts of the blood are partly of the fixed neutral kind, and partly such as are rendered semi-volatile by the heat and motion to which they are subjected: Both irritate the sensible nervous parts of animals; for it is well-known that any kind of salt applied to the eye gives great uneasiness. From these qualities of blood the late learned and celebrated Dr Whytt concluded that it must be well fitted to communicate a gentle stimulus to those sensible nerves which terminate on the internal surface of the auricles and ventricles of the heart; and consequently that the contraction of the heart is principally owing to this cause. The diameter of a red globule is computed to be about  $\frac{1}{800}$  part of an inch. See **CIRCULATION**; and for the analysis of blood, see **CHEMISTRY**.

Authors are not agreed in regard to the quantity of blood contained in the human body; some making it only 10 pounds, whilst others make it to be 20, 60, or even 100 pounds: But then these last comprehend the juices of the lymphatic vessels under the term blood. As to the quantity of current blood in a horse, the ingenious Dr Hales found it be, at a low computation, 1105 cubic inches, or 42.2 pounds.

*Spitting of BLOOD*. See **HÆMORRHOË** and **MEDICINE**.

*Ebullition of the BLOOD*, a disease in horses, which proceeds from want of exercise, and gives rise to outward swellings, frequently mistaken for the farcin.

**BLOOD running itch** happens to a horse by the blood's being over-heated by hard riding or other labour. As the blood gets between the skin and the flesh, it makes a horse rub and bite himself, and if neglected will turn to a grievous mange.

**BLOOD of Christ**, the name of a military order instituted at Mantua in 1608. The number of knights

was restricted to twenty, besides the grand master. Their device was, *Domine probasti me*, or, *Nibil hoc, trifle, recepto*.

**BLOOD of Christ** is also the name of a congregation of nuns at Paris.

**Dragon's BLOOD**. See **DRAGON**.

**BLOOD-snake**. See **ANGUIS**.

**BLOOD-stone**. See **HÆMATITES**.

**BLOOD-wit**, a mulct or fine for shedding of blood.

**BLOOD-wort**, in botany. See **SANGUINARIA**.

**BLOODY-flux**. See **DYSENTERY**, and **MEDICINE**.

**BLOOM**, a mass of iron after having undergone the first hammering, called blomary. See **BLOMARY**.

**BLOSSOM** denotes the flowers of plants, but more especially of fruit-trees.

**BLOSSOM**, or **PEACH-COLOURED**, in the menage, a term applied to a horse that has his hair white, but intermixed all over with sorrel and bay hairs. Such horses are so insensible and hard both in the mouth and the flanks, that they are scarce valued; besides, they are apt to turn blind.

**BLOW**, in law, any kind of stroke, whether given with the hand or a weapon. See **BATTERY**.

**Blow-pipe**, or **BLOWING-pipe**, a hollow tube, used by several artificers; as enamellers, glass-makers, &c.

**BLOWING**, in a general sense, denotes an agitation of the air, whether performed with a pair of bellows, the mouth, a tube, or the like.

**BLOWING of glass**, one of the methods of forming the divers kinds of works in the glass-manufacture. See **GLASS**.

It is performed by dipping the point of an iron blowing-pipe in the melted glass, and blowing through it with the mouth, according to the circumstances of the glass to be blown.

**BLOWING of tin** denotes the melting its ore, after being first burnt to destroy the mundic.

**BLOWING**, among gardeners, the same with the blossoming of plants, or putting forth their flower-leaves.

**BLUBBER** denotes the fat of whales and other large sea-animals, whereof is made train-oil.

**BLUE**, otherwise called *azuro*, is one of the primitive colours of the rays of light. See **OPTICS**.

**Painters BLUE** is made different according to the different kinds of painting. In limning, fresco, and miniature, they use indifferently ultramarine, blue-ashes, and smalt: These are their natural blues, excepting the last, which is partly natural, and partly artificial.

In oil and miniature, they also use indigo prepared; as also a fictitious ultramarine. See **ULTRAMARINE** and **INDIGO**.

Enamellers, and painters upon glass, have also blues proper to themselves, each preparing them after their own manner.

**Turnsole BLUE** is used in painting on wood; and is made of the seed of the turnsole: The way of preparing it is, to boil four ounces of turnsole in a pint and half of water in which lime has been slacked.

**Flanders BLUE** is a colour bordering on green, and seldom used but in landscapes.

*To write on paper or parchment with BLUE ink.* Grind blue with honey, then temper it with glair of eggs, or gum made of isinglass.

**BLUEING of metals** is performed by heating them in the fire, till they assume a blue colour; particularly practised by gilders, who blue their metals before they apply the gold and silver leaf.

*To dye skins BLUE.* Boil elder-berries or dwarf-elder, then smear and wash the skins therewith, and wring them out; then boil the berries, as before, in a solution of alum-water, and wet the skins in the same manner once or twice; dry them, and they will be very blue.

**Dyers BLUE** is one of their simple or mother-colours, used in the composition of others. It is made of woad, indigo, and a pastel brought from Normandy. Some dyers heighten their blue, by adding Brazil and other woods.

*A BLUE for painting or staining of glass.* Take fine white sand twelve ounces, zaffer and minium of each three ounces; reduce these to a fine powder in a bell-metal mortar; then putting the powder into a very strong crucible, cover it and lute it well, and, being dry, calcine it over a quick fire for an hour; take out the matter and pound it; then to sixteen ounces of this powder add fourteen of nitre powder; mix them well together, and put them into the crucible again; cover and lute it, and calcine for two hours on a very strong fire.

**Prussian BLUE.** This blue is next to ultramarine for beauty, if it be used in oil: This colour does not grind well in water.

**BLUE bice** is a colour of good brightness, next to Prussian blue; and also a colour of a body, and will flow pretty well in the pencil.

**Saunders BLUE** is also of very good use, and may serve as a shade to ultramarine or the blue bice, where the shades are not required to be very deep, and is of itself a pleasant blue, to be laid between the light and shades of such a flower as is of a mazarine blue.

*A fine BLUE from Mr Boyle.* Take the blue leaves of rue, and beat them a little in a stone mortar with a wooden pestle; then put them in water, juice and all, for fourteen days or more, washing them every day till they are rotten; and at last beat them and the water together, till they become a pulp, and let them dry in the sun. This is a fine blue for shading.

**Indigo-BLUE.** This makes the strongest shade for blues of any other, and is of a soft warm colour, when it has been well ground, and washed with gum-water, by means of a stone and a muller.

**Lacmus, or Litmus BLUE.** This is a beautiful blue, and will run in a pen as free as ink. It is made of lacmus, and prepared thus: Take an ounce of lacmus, and boil it in a pint of small-beer wort, till the colour is as strong as you would have it; then pour off the liquor into a gallipot, and let it cool for use. This affords a beautiful colour, has extraordinary effects, and is a holding colour; if it be touched with aqua-fortis, it immediately changes to a fine crimson, little inferior to carmine.

**BLUE-Japan.** Take gum-water, what quantity you please, and white lead a sufficient quantity; grind them well upon a porphyry; then take isinglass size what quantity you please, of the finest and best smalt a sufficient quantity, mix them well; to which add, of your white lead, before ground, so much as may give it a sufficient body; mix all these together to the consistence of a paint.

**BLUE-bottle,** in botany. See **CYANUS**.

**BLUE-cap,** in ichthyology. See **SALMO**.

**BLUE-mantle,** in heraldry, the title of a pourfuirant at arms.

**BLUFF-HEAD,** among sailors. A ship is said to be bluff-headed, that has an upright stern.

**BLUNDERBUSS,** a short fire-arm with a wide bore, capable of holding a number of bullets at once.

**BLUSHING,** a suffusion, or redness of the cheeks, excited by a sense of shame, on account of a consciousness of some failing or imperfection.

**B MI,** in music, the third note in the modern scale. See **SCALE** and **MUSIC**.

**B MOLLARRE, or MOLLE,** one of the notes of the scale of music, usually called soft or flat, in opposition to **b quandro**. See **B QUANDRO**.

**BOA,** in zoology, a genus of serpents, belonging to the order of amphibia. The characters of this genus are, that the belly and tail are both furnished with scuta. The species are ten, *viz.* 1. The contortrix, has 150 scuta on the belly, and 40 on the tail; the head is broad, very convex, and has poison-bags in the mouth, but no fang, for which reason its bite is not reckoned poisonous: The body is ash-coloured, interspersed with large dusky spots; and the tail is about a third of the length of the body. This serpent is found in Carolina. 2. The canina, has 203 scuta on the belly, and 77 on the tail; it is greenish, and variegated with white belts. It is a native of America, and lodges in the hollow trunks of trees, and is about two feet long. The bite of the canina is not poisonous. 3. The hipnale, is of a dull yellow colour, and is found in Asia. It has 179 scuta on the belly, and 120 on the tail.—4. The constrictor, has 240 scuta on the belly, and 60 on the tail. This is an immense animal; it often exceeds 36 feet in length; the body is very thick, of a dusky white colour, and its back is interspersed with 24 large pale irregular spots; the tail is of a darker colour; and the sides are beautifully variegated with pale spots. Besides, the whole body is interspersed with small brown spots. The head is covered with small scales, and has no broad laminae betwixt the eyes, but has a black belt behind the eyes. It wants the large dog-fangs, and of course its bite is not poisonous. The tongue is fleshy, and very little forked. Above the eyes, on each side, the head rises high. The scales of this serpent are all very small, roundish, and smooth. The tail does not exceed one eighth of the whole length of the animal. The Indians, who adore this monstrous animal, use the skin for cloaths, on account of its smoothness and beauty. There are several of these skins of the above dimensions preserved, and to be seen in the different mu-

seums

feums of Europe, particularly in the library and botanic garden of Upsal in Sweden, which has of late been greatly enriched by count Grillinborg. The flesh of this serpent is eat by the Indians, and the negroes of Africa. Piso, Margraave, and Kempfer give the following account of its method of living and catching its prey. It frequents caves and thick forests, where it conceals itself, and suddenly darts out upon travellers, wild beasts, &c. When it chuses a tree for its watching-place, it supports itself by twisting its tail around the trunk or a branch, and darts down upon sheep, goats, tigers, or any animal that comes within its reach. When it lays hold of animals, especially any of the larger kinds, it twists itself several times round their body, and, by the vast force of its circular muscles, bruises and breaks all their bones. After the bones are broke, it licks the skin of the animal all over, besmearing it with a glutinous kind of saliva. This operation is intended to facilitate deglutition, and is a preparation for swallowing the whole animal. If it be a stag, or any horned animal, it begins to swallow the feet first, and gradually sucks in the body, and last of all the head. When the horns happen to be large, this serpent has been observed to go about for a long time with the horns of a stag sticking out from its mouth. As the animal digests, the horns putrify and fall off. After this serpent has swallowed a stag or a tyger, it is unable for some days to move; the hunters, who are well acquainted with this circumstance, always take this opportunity of destroying it. When irritated, it makes a loud hissing noise. This serpent is said to cover itself over with leaves in such places as stags or other animals frequent, in order to conceal itself from their sight, and that it may the more easily lay hold of them. See Plate LII. fig. 1.—5. The murina, has 254 scuta on the belly, and 65 on the tail. The colour of it is a light blue, with round spots on the back. It is a native of America, and its bite is not poisonous. 6. The scytale, has 250 scuta on the belly, and 70 on the tail. The body is ash-coloured and bluish, with round black spots on the back, and black lateral rings edged with white. This serpent is a native of America; and, like the constrictor, though not so long, twists itself about sheep, goats, &c. and swallows them whole. 7. The cenchria, has 265 scuta on the belly, and 57 on the tail. It is of a yellow colour, with white eye-like spots. It is a native of Surinam, and its bite is not poisonous. 8. The ophrias, has 281 scuta on the belly, and 64 on the tail; the colour is nearly the same with that of the constrictor, but browner. The place where this serpent is to be found is not known; but its bite is not venomous. 9. The enydris, has 270 scuta on the belly, and 105 on the tail. The colour is a dusky white, and the teeth of the lower jaw are very long; but its bite is not poisonous. It is a native of America. 10. The hortulana, has 290 scuta on the belly, and 128 on the tail. It is of a pale colour, interspersed with livid wedge-like spots. It is a native of America, and its bite is not poisonous.—For the nature and qualities of serpents in ge-

neral, their method of propagation, &c. see NATURAL HISTORY.

BOAR, a male swine. See SUS.

BOAR, in the menage. A horse is said to boar, when he shoots out his nose as high as his ears, and tosses his nose in the wind.

BOARD, a long piece of timber, sawed thin for building and several other purposes. See TIMBER.

Barrel-BOARDS, imported from Ireland, Asia, or Africa, pay only 11  $\frac{1}{4}$  d. the hundred; but if imported from elsewhere, they pay 1 s. 5  $\frac{1}{4}$  d. Clap-boards pay 4 s. 9  $\frac{1}{4}$  d. the hundred; but if imported from Ireland, Asia, or Africa, only 2 s. 10  $\frac{1}{4}$  d. Pipe-boards pay 5 s. 8  $\frac{1}{4}$  d. the hundred; but if from Ireland, &c. only 3 s. 10  $\frac{1}{4}$  d. Scale-boards pay 8 s. 5  $\frac{1}{4}$  d. the hundred weight; and  $\frac{1}{4}$  d. more if imported in foreign bottoms.

BOARD, among seamen. *To go aboard*, signifies to go into the ship. *To slip by the board*, is to slip down by the ship's side. *Board and board*, is when two ships come so near as to touch one another, or when they lie side by side. *To make a board*, is to turn to windward; and the longer your boards are, the more you work into the wind. *To board it up*, is to beat it up, sometimes upon one tack, and sometimes upon another. *She makes a good board*, that is, the ship advances much at one tack. *The weather-board*, is that side of the ship which is to windward.

BOARD is also used for an office under the government: thus we say, the board of trade and plantations, the board of works, ordnance, &c.

BOARDING a ship, is entering an enemy's ship in a fight.

In boarding a ship, it is best to bear up directly with him, and to cause all your ports to leeward to be beat open; then bring as many guns from your weather side as you have ports for; and laying the enemy's ship, on board, loof for loof, order your tops and yards to be manned and furnished with necessaries; and let all your small shot be in a readiness; then charge at once with both small and great, and at the same time enter your men under cover of the smoke, either on the bow of your enemy's ship, or bring your midship close up with her quarter, and so enter your men by the shrouds: or if you would use your ordnance, it is best to board your enemy's ship athwart her hawse; for in that case you may use most of your great guns, and the only those of her prow. Let some of your men endeavour to cut down the enemy's yards and tackle, whilst others clear the decks, and beat the enemy from aloft. Then let the scuttles and hatches be broke open with all possible speed to avoid trains, and the danger of being blown up by barrels of powder placed under the decks.

BOAT, a small open vessel, commonly wrought by rowing.

BOATSWAIN, a ship-officer, to whom is committed the charge of all the tacklings, sails, and rigging, ropes, cables, anchors, stags, pendants, &c. He is also to take care of the long-boat and its furniture, and to steer her either by himself or his mate.

He

He calls out the several gangs and companies aboard, to the due execution of their watches, works, spells, &c. He is likewise provost-marshal, who sees and punishes all offenders sentenced by the captain, or a court-martial of the fleet.

**BOATSWAIN'S mats** has the peculiar command of the long boat, for the setting forth of anchors, weighing or fetching home an anchor, warping, towing, or mooring; and is to give an account of his store.

**BOB**, a term used for the ball of a short pendulum.

**BOBARTIA**, in botany, a genus of the triandria digynia class. The calix is imbricated; and the corolla consists of a double-valved gluma. There is but one species, *viz.* the indica, a native of the Indies.

**BOBBIN**, a small piece of wood turned in the form of a cylinder, with a little border jutting out at each end, bored through to receive a small iron pivot. It serves to spin with the spinning-wheel, or to wind thread, worsted, hair, cotton, silk, gold, and silver.

**BOBBING**, a method of fishing. See **FISHING**.

**BOBBIO**, a town of the Milanese, in Italy, about twenty-eight miles south-east of Pavia; E. long.  $10^{\circ}$ , N. lat.  $44^{\circ} 35'$ .

**BOCA**, in ichthyology. See **SPARUS**.

**BOCA-CHICA**, the entrance into the harbour of Carthage, in South America, defended by several forts.

**BOCA DEL DRAGO**, a strait between the island of Trinidad and New Andalusia, a province of Terra Firma. See **TERRA FIRMA**.

**BOCARDO**, among logicians, the fifth mode of the third figure of syllogisms, in which the middle proposition is an universal affirmative, and the first and last particular negatives, thus:

**Bo** Some sickly persons are not students;

**Car** Every sickly person is pale;

**Do** Therefore some persons are pale that are not students.

**BOCCONIA**, in botany, a genus of the dodecandria monogynia class. There is only one species, *viz.* the frutescens, a native of America.

**BOCE**, in ichthyology. See **SPARUS**.

**BOCHARA**, a large town of Ubec Tartary, situated on the river Oxus, about sixty miles west of Samarcand, in  $65^{\circ}$  E. long. and  $40^{\circ}$  N. lat.

**BOCKHOLT**, a town of Munster, in Westphalia, situated in  $6^{\circ} 20'$  E. long. and  $51^{\circ} 40'$  N. lat.

**BOCK-LAND**, in the Saxons time, is what we now call freehold lands, held by the better sort of persons by charter or deed in writing; by which name it was distinguished from folkland, or copy-hold land, holden by the common people without writing.

**BODKIN**, a small instrument made of steel, bone, ivory, &c. used for making holes.

The small grofs, or twelve dozen, of bodkins pays on importation 1 s.  $3\frac{1}{2}$  d.; if of iron or steel, 4 s.  $8\frac{1}{2}$  d.; and if of brass, only 3 s.  $7\frac{1}{2}$  d.

**BODMIN**, a borough-town of Cornwall, about twenty-six miles north-east of Falmouth, in  $5^{\circ} 10'$  W. long. and  $50^{\circ} 32'$  N. lat. It sends two members to parliament, and gives the title of viscount to the earl of Radnor.

**BODROCH**, a town of Hungary, about an hundred miles south-east of Buda, and situated on the north-east shore of the Danube, in  $20^{\circ} 15'$  E. long. and  $46^{\circ} 15'$  N. lat.

**BODY**, in physics, an extended solid substance, of itself utterly passive and inactive, indifferent either to motion or rest. See **MATTER**, and **MECHANICS**.

*Colour of BODIES.* See **OPTICS**.

*Descent of BODIES.* See **MECHANICS**.

*Division of BODIES.* See **CHEMISTRY**.

**BODY**, with regard to animals, is used in opposition to soul, in which sense it makes the subject of anatomy.

**BODY**, among painters, as to bear a body, a term signifying that the colours are of such a nature, as to be capable of being ground so fine, and mixing with the oil so intirely, as to seem only a very thick oil of the same colour.

**BODY**, in the manege. A horse is chiefly said to have a good body, when he is full in the flank. If the last of the short ribs be at a considerable distance from the haunch bone, although such horses may, for a time, have pretty good bodies, yet, if they are much laboured, they will lose them; and these are properly the horses that have no flank. It is also a general rule, that a man should not buy a light-bodied horse, and one that is fiery, because he will soon destroy himself.

**BODY**, in the art of war, a number of forces, horse and foot, united and marching under one commander.

*Main BODY of an army*, the troops encamped in the centre between the two wings, and generally infantry; the other two bodies are the vanguard and the rear-guard; these being the three into which an army, ranged in form of battle, is divided.

**BODY**, in matters of literature, denotes much the same with system, being a collection of every thing belonging to a particular science or art, disposed in proper order: thus, we say, a body of divinity, law, physics, &c.

**BOEDROMIA**, in Grecian antiquity, a festival celebrated yearly by the Athenians in the month Boedromion; for the ceremonies of which, see Potter's *Arch. Græc.* b. ii. c. 20.

**BOEDROMION**, in chronology, the third month of the Athenian year, answering to the latter part of our August and beginning of September.

**BOERHAAVIA**, in botany, a genus of the monandria monogynia class. It has no calix; the corolla consists of one bell-shaped plaited petal; and there is but one naked seed. There are six species, all natives of the Indies.

**BOESCHOT**, a town of the Austrian Netherlands, situated in Brabant, about twelve miles north-east of Malines, in  $4^{\circ} 40'$  E. long. and  $51^{\circ} 5'$  N. lat.

**BOG** properly signifies a quagmire, covered with grass, but not solid enough to support the weight of the body.

**BOG**, in geography, a river of Poland, which, running south-east through the province of Podolia and Buziac Tartary, falls into the Euxine sea between Oczakow and the mouth of the Boristhenes.

**BOG**, or **BOG of GIGHT**, a small town of Scotland, near

near the mouth of the river Spey, situated in  $2^{\circ} 23'$  W. long. and  $57^{\circ} 40'$  N. lat.

**BOGARMITÆ.** See **BOGOMILI.**

**BOGDOI,** a great nation of Tartary in Asia. The Chinese call them eastern Tartars; and in the Mogul's country they are called Niuchi or Nuchi.

**BOGHO,** or **BUEIL,** a town in the county of Nice, in Piedmont, situated on the frontiers of France, about twenty-five miles north-west of Nice, in  $6^{\circ} 45'$  E. long. and  $44^{\circ} 12'$  N. lat.

**BOGOMILI,** or **BOGARMITÆ,** in church-history, a sect of heretics, which sprung up about the year 1179. They thought that but seven books of the scripture are to be received, that the use of churches, of the sacrament of the Lord's supper, and all prayer, except the Lord's prayer, ought to be abolished; that the baptism of Catholics is imperfect; that the persons of the Trinity are unequal, and that they oftentimes made themselves visible to those of their sect. They said, that devils dwelt in the churches, and that Satan had resided in the temple of Solomon from the destruction of Jerusalem to their own time.

**BOGOTO,** the capital of New Granada, in Terra Firma, situated in  $74^{\circ}$  W. long. and  $4^{\circ}$  N. lat.

**BOHEA,** in commerce, one of the best kinds of tea that come from China. There are three sorts of it: the first is bought at Canton for 80 tals *per picë*; the second for 45; and the third for 25. See **TEA.**

**BOHEMIA,** a kingdom subject to the house of Austria, bounded by Saxony on the north, by Poland and Hungary on the east, by Austria on the south, and by Bavaria and part of Saxony on the west. It lies between  $12^{\circ}$  and  $17^{\circ}$  E. long. and  $48^{\circ}$  and  $52^{\circ}$  N. lat.

**BOHEMIAN Bole.** See **BOLE.**

**BOHOL,** one of the Philippine islands, in Asia; E. long.  $122^{\circ}$ , N. lat.  $10^{\circ}$ .

**BOJANO,** a city of Molise, in the kingdom of Naples, about fifteen miles north of Benevento; E. long.  $15^{\circ} 20'$ , and N. lat.  $41^{\circ} 20'$ .

**BOJARS** denote Russian noblemen. See **RUSSIA.**

**BOIGUACU,** in zoology, a synonyme of the boa constrictor. See **BOA.**

**BOIL,** or **FURUNCLE,** in surgery. See **FURUNCLE.**

**BOILING,** or **EBULLITION,** the agitation of a fluid body, arising from the application of fire. See **CHEMISTRY.**

**BOIQUIRA,** the American name for the rattle-snake.

**BOIS de soignies,** the forest of Soignies, in the Austrian Netherlands, and province of Brabant, about three miles south-east of Brussels.

**BOISLEDUC,** called by the Dutch Hertogenbosch, a large fortified town of Dutch Brabant, situated on the river Bonmel, about twenty-three miles north-east of Breda; E. long.  $5^{\circ} 20'$ , and N. lat.  $51^{\circ} 45'$ .

**BOKHARAH,** **БОГАР,** or **БОГНАР,** a city of Tartary, in the country of the Uzbeks, near Gihum and Bikant.

**BOLES** are viscid earths, less coherent and more friable than clay, more readily uniting with water, and more freely subsiding from it. They are soft and unctuous to the touch, adhere to the tongue, and by degrees melt in the mouth, impressing a light sense of

astringency. There are a great variety of these earths; the principal of which are the following.

1. Armenian bole, when pure, is of a bright red colour, with a tinge of yellow: It is one of the hardest and most compact of the bodies of this class, and not smooth and glossy like the others, but generally of a rough dusty surface. It does not effervesce with acids.
2. French bole is of a pale red colour, variegated with irregular specks of white and yellow. It is much softer than the Armenian, and slightly effervesces with acids.
3. Bole of Blois is yellow, remarkably lighter than the most of the other yellow earths, and effervesces strongly with acids.
4. Bohemian bole is of a yellow colour, with a cast of red, and generally of a flaky texture. It is not acted on by acids.
5. Lemnian earth is of a pale red colour, and slightly effervesces with acids.
6. Silesian bole is of a brownish yellow colour, and acids have no sensible effects upon it.

These and other earths, made into little masses, and stamped with certain impressions, are called *terra sigillata*. These earths have been recommended as astringent, sudorific, and alexipharmic. But these, and many other virtues that have been ascribed to them, appear to have no foundation. They are still used in fluxes and complaints of the first passages.

**BOLETUS,** in botany, a genus of the cryptogamia fungi class. This mushroom is horizontal, spongy, and porous below. There are 14 species, of which seven are natives of Britain, *viz.* the suberosus, or cork boletus; the fomentarius, or spongy boletus; the versicolor, or striped boletus; the albus, or white boletus; the igniarius, or hard boletus, or touchwood; the bovinus, or brown boletus; and the luteus, or yellow boletus.

**BOLINGBROKE,** or **BULLINGBROKE,** a market-town of Lincolnshire, about twenty-five miles east of Lincoln; E. long.  $15^{\circ}$ , N. lat.  $53^{\circ} 15'$ .

**BOLISLAW,** a town of Bohemia, about thirty miles north-east of Prague; E. long.  $14^{\circ} 40'$ , N. lat.  $50^{\circ} 25'$ .

**BOLLARDS,** large posts set into the ground, on each side of a dock. On docking or undocking ships, large blocks are lashed to them; and through these blocks are reeved the transposing hawfers to be brought to the capstons.

**BOLLITO,** a name by which the Italians call a sea-green colour in artificial crystal. To prepare this colour, you must have in the furnace a pot filled with forty pound of good crystal, first carefully skimmed, boiled, and purified, without any manganese: then you must have twelve ounces of the powder of small leaves of copper, thrice calcined, half an ounce of zaffer in powder; mix them together, and put them at four times into the pot, that they may the better mix with the glass, stirring them well each time of putting in the powder, for fear that it should swell too much and run over.

**BOLOGNA,**



- BOLOGNA**, a city of Italy, fifty miles north of Florence. It is about five miles in circumference, and is remarkable for its magnificent churches and monasteries, as well as for its university, which is one of the most considerable in Europe; E. long.  $11^{\circ} 40'$ , and N. lat.  $44^{\circ} 30'$ .
- BOLOGNE**. See **BOULOGNE**.
- BOLONIAN stone**, is a sulphureous kind of stone, about the bigness of a walnut, found near Bologna; which, when duly prepared by calcination, makes a species of phosphorus. See **PHOSPHORUS**.
- BOLSENNÀ**, a town of the pope's territories in Italy, about forty-five miles north of Rome, at the north end of a lake to which it gives name; E. long.  $13^{\circ} 45'$ , and N. lat.  $42^{\circ} 40'$ .
- BOLSLAW**, a town of Bohemia, situated on the river Sizera, about thirty miles north-east of Prague; E. long.  $14^{\circ} 45'$ , and N. lat.  $50^{\circ} 24'$ .
- BOLSTERS** of a saddle, those parts of a great saddle which are raised upon the bows, both before and behind, to hold the rider's thigh, and keep him in a right posture.
- BOLSWAERT**, a town of West Friesland, in the United Provinces, about eighteen miles south-west of Lewarden; E. long.  $5^{\circ} 20'$ , and N. lat.  $53^{\circ} 10'$ .
- BOLT**, among builders, an iron fastening fixed to doors and windows. They are generally distinguished into three kinds, viz. plate, round, and spring bolts.
- Bolts in gunnery are of several sorts; as, 1. Transum bolts, that go between the cheeks of a gun-carriage, to strengthen the transums. 2. Prile-bolts, the large knobs of iron on the cheeks of a carriage, which keep the hand-spike from sliding when it is pointing up the breech of a piece. 3. Traverse-bolts, the two short bolts that being put one in each end of a mortar-carriage, serve to traverse her. 4. Bracket-bolts, the bolts that go through the cheeks of a mortar, and by the help of quoins keep her fixed at the given elevation. And, 5. Bed-bolts, the four bolts that fasten the brackets of a mortar to the bed.
- Bolts in a ship are iron pins, of which there are several sorts, according to their different makes and uses. Such are drive-bolts, used to drive out others. Ray-bolts, with jags or barbs on each side, to keep them from flying out of their holes. Clench-bolts, which are clenched with riveting hammers. Forelock-bolts, which have at the end a forelock of iron driven in, to keep them from starting back. Set-bolts, used for forcing the planks, and bringing them close together. Feed or fender-bolts, made with long and thick heads, and struck into the uttermost bends of the ship, to save her sides from bruises. And ring-bolts, used for bringing to of the planks, and those parts whereto are fastened the breeches and tackles of the guns.
- BOLT** of canvas, in commerce, the quantity of twenty-eight ells.
- BOLT-rope**. See **ROPE**.
- BOLTING**, a term formerly used in our inns of court, for the private arguing of causes. An ancient and two barristers sat as judges; and three students, bringing each a case, out of which the judges chose one to
- argued, the students first began to argue it, and after them the barristers. It was inferior to moot. See **MOOT**.
- BOLTON**, a market-town of Lancashire, about twenty-seven miles north-east of Liverpool; W. long.  $2^{\circ} 20'$ , and N. lat.  $53^{\circ} 35'$ .
- BOLUS**, an extemporaneous form of a medicine, soft, coherent, a little thicker than honey, and the quantity of which is a little morfel or mouthful; for which reason it is by some called *buccella*.
- Whatever is fit for internal use, either by itself, or when mixed with other substances, provided it is capable of the above mentioned consistence, is a proper material for the composition of a bolus. Such are soft substances more or less thick, as conserves, electuaries, robs, pulps, extracts; syrups and liquid substances, as oils, spirits, essences, elixirs, &c. The dose of bolus may be extended from one dram to one dram and a half, or two drams.
- BOLZAS**, a sort of ticking which comes from the East-Indies.
- BOMAL**, a town of Luxemburg, in the Austrian Netherlands, situated on the river Ourt, about 20 miles south of Liege; in  $5^{\circ} 30'$  E. long. and  $50^{\circ} 20'$  N. lat.
- BOMB**, in military affairs, a large shell of cast iron, having a great vent to receive the fusee, which is made of wood. The shell being filled with gunpowder, the fusee is driven into the vent or aperture, within an inch of the head, and fastened with a cement made of quick-lime, ashes, brick-dust, and steel-slings, worked together in a glutinous water; or of four parts of pitch, two of colophony, one of turpentine, and one of wax. This tube is filled with a combustible matter, made of two ounces of nitre, one of sulphur, and three of gunpowder dust, well rammed. To preserve the fusee, they pitch it over, but uncase it when they put the bomb into the mortar, and cover it with gunpowder dust; which having taken fire by the flash of the powder in the chamber of the mortar, burns all the time the bomb is in the air; and the composition in the fusee being spent, it fires the powder in the bomb, which bursts with great force, blowing up whatever is about it. The great height the bomb goes in the air, and the force with which it falls, makes it go deep into the earth.
- BOMB-CHEST**, a kind of chest usually filled with bombs, sometimes only with gunpowder, placed under ground to tear it and blow it up in the air, with those who stand on it. It was set on fire by means of a faucisic fastened at one end, but is now much disused.
- BOMB-BATTERY**. See **BATTERY**.
- BOMBARD**, a piece of ordnance anciently in use, exceedingly short and thick, and with a very large mouth. There have been bombards which have thrown a ball of 300 pound weight. They made use of cranes to load them.
- The bombard is by some called *basilia*, and by the Dutch, *donderbus*.
- BOMBARDIER**, a person employed about a mortar. His business is to drive the fusee, fix the shell, load and fire the mortar.

**BOMBARDMENT**, the havoc committed in throwing bombs into a town or fortrefs.

**BOMBARDO**, a musical instrument of the wind kind, much the fame as the bassoon, and used as a bass to the hautboy.

**BOMBASINE**, a name given to two sorts of stuffs, the one of silk, and the other crossed, of cotton.

Bombasine of silk pays duty on importation as other foreign silks. See **SILK**. That of cotton pays each piece, not exceeding 15 yards, if narrow, 1l. 3s. 1 $\frac{2}{3}$ d. but if broad, 1l. 6s. 11 $\frac{2}{3}$ d.

**BOMBAST**, in composition, is a serious endeavour, by strained description, to raise a low or familiar subject beyond its rank; which instead of being sublime, never fails to be ridiculous. The mind, in some animating passions, is indeed apt to magnify its objects beyond natural bounds. But such hyperbolical description has its limits, and, when carried beyond these, it degenerates into burlesque, as in the following example:

*Sejanus.* — Great and high

The world knows only two, that's Rome and I.

My roof receives me not; 'tis air I tread,

And at each step I feel my advanc'd head

Knock out a star in heaven.

*Sejan. Ben. Johnson, act 5.*

A writer who has no natural elevation of genius is extremely apt to deviate into bombast: He strains above his genius, and the violent effort he makes carries him generally beyond the bounds of propriety.

**BOMBAX**, or **COTTON-TREE**, in botany, a genus of the monodelphia polyandria class. It has but one stylus; the stigma consists of five lobes; the capsule has five cells; and the seeds are downy. There are three species, *viz.* the pentandrum, the ceiba, and the heptaphyllum, all natives of the Indies. The cotton-tree grows generally above 60 feet high, and is so thick that the Indians dig canoes which hold several men out of the whole wood. There are hollows in different parts of the trunk which contain large quantities of water, which is of great use to travellers in the hot climates where there is often a scarcity of water. For the method of making cotton, see **COTTON**.

**BOMBAX**, in zoology, a synonyme of a species of conus. See **CONUS**.

It is sometimes used for silk or cotton. It is likewise applied by Linnæus to signify such insects as have incumbent wings and feelers resembling a comb.

**BOMBAY**, an island on the west coast of the hither peninsula of India, situated in 72° 20' E. long. and 18° 30' N. lat. It is about seven miles long, and twenty in circumference; and is the property of our East-India company.

**BOMB-KETCH**, a small vessel built and strengthened with large beams for the use of mortars at sea.

**BOMBUS**, in medicine, a resounding and ringing noise in the ear.

**BOMBYLIUS**, in zoology, a genus of insects belonging to the order of diptera. The rostrum is long, bristly, and bivalved; the bristles being fixed between the horizontal valves. There are five species, *viz.* 1. The major, with black wings. 2. The medius, with

a yellowish body, white behind, and the wings spotted with yellow. 3. The minor, with unspotted wings.

4. The ater, has red wings, but a little blackish at the base; and green feet. The above four are natives of Europe. 5. The capensis, with the wings spotted with black; an ash-coloured body, and white behind.

It is a native of the Cape of Good Hope.

**BOMENE**, a port-town of Zeland, in the United Provinces, situated on the northern shore of the island of Schouen, opposite to the island of Goree; in 4° E. long. and 51° 50' N. lat.

**BOMMEL**, a town of Dutch Guelderland, situated on the northern shore of the river Waal, about four miles north-east of Nimeguen; in 5° 50' E. long. and 52° N. lat.

**BOMONICI**, in Grecian antiquity, young men of Lacedæmon, who contended at the sacrifices of Diana which of them was able to endure most lashes; being scourged before the altar of this goddess.

**BON**, in geography, a town of the electorate of Cologne, in Germany, situated on the western shore of the river Rhine, about 12 miles south of Cologne; in 7° E. long. and 50° 35' N. lat. It is a small but well fortified town, and has a fine palace, which the elector of Cologne makes his usual residence.

**BON** is also the name of one of the Molucca islands, lying west of Coram.

**BONA**, in geography, a port-town of the kingdom of Algiers, in Africa, about 200 miles east of the city of Algiers; in 8° E. long. and 36° N. lat.

There is also a cape called Bona on the same coast to the eastward, almost opposite to Sicily.

**BONA-FIDES**, in law: When a person performs any action, which he believes at the time to be just and lawful, he is said to have acted *bona fide*.

**BONA MOBILIA**, the same with moveable goods or effects.

**BONA NOTABILIA**, are such goods as a person dying has in another diocese than that wherein he dies, amounting to the value of 5l. at least; in which case the will of the deceased must be proved, or administration granted in the court of the archbishop of the province, unless by composition, or custom, any dioceses are authorized to do it, when rated at a greater sum.

**BONA PATRIA**, an assize of country men, or good neighbours, where twelve or more are chosen out of the country to pass upon an assize, being sworn judicially in the presence of the party.

**BONA**, in geography, a cape of Africa, near Tunis, in the Mediterranean sea.

**BONAIRE**, an island near the coast of Terra Firma, in South America, situated in 67° W. long. and 12° 30' N. lat. It is subject to the Dutch, who traffic from thence with the Caracao-coast.

**BONAROTA**, in botany, the trivial name of a species of *pæderota*. See **PÆDEROTA**.

**BONASIUS**, in zoology, the trivial name of a species of bos. See **BOS**.

**BONAVENTURA**, a sea-port town in Popayan in South America, upon the South sea.

**BONAVISTA**, one of the Cape Verd Islands, subject to Portugal; in 23° W. long. and 16° 30' N. lat.

**BOND**,

**BOND**, in Scots law, a formal writing by which a person binds himself to pay a certain sum of money to another, or to perform a certain deed, under a penalty. Bonds respecting money are divided into heritable and moveable. See *LAW*, tit. *Heritable and moveable rights*.

**BOND**, in carpentry, a term among workmen; as, to make good bond, means that they should fasten two or more pieces together, either by tenanting, mortising, or dovetailing, &c.

**BONDAGE**, properly signifies the same with slavery; but, in old law-books, is used for villenage. See *VILLENAGE*.

**BOND-MAN**, the same with villain. See *VILLAIN*.

**BONDOUR**, a city of Natolia in Asia.

**BONDUC**, in botany, the trivial name of a species of guilandria. See *GUILANDRIA*.

**BONE**, in anatomy. See *PART I*.

**BONE-ACE**, an easy but licking game at cards, played thus: The dealer deals out two cards to the first hand, and turns up the third, and so on through all the players, who may be seven, eight, or as many as the cards will permit; he that has the highest card turned up to him, carries the bone, that is, one half of the stake, the other remaining to be played for: Again, if there be three kings, three queens, three tens, &c. turned up, the eldest hand wins the bone: But it is to be observed, that the ace of diamonds is bone-ace, and wins all other cards whatever. Thus much for the bone; and as for the other half of the stake, the nearest to thirty-one wins it; and he that turns up or draws thirty-one, wins it immediately.

**BON-ESPERANCE**, the same with the Cape of Good-hope. See *GOOD-HOPE*.

**BONGO**, or **BUNGO**, the capital of one of the islands of Japan, to which it gives name; in 132° E. long. and 32° 30' N. lat. It is a sea port town, situated on the east side of the island, opposite to the island of Tonfa, from which it is separated by a narrow channel.

**BONIFACIO**, in geography, a port-town of Corsica, situated at its south end, in 9° 20' E. long. and 41° 20' N. lat. It is one of the best towns in the whole island, and gives name to the streight between Corsica and Sardinia.

**BONIS non amovendis**, in law, is a writ directed to the sheriffs of London, &c. charging them, that a person, against whom judgment is obtained, and prosecuting a writ of error, be not suffered to remove his goods until the error is determined.

**BONNET**, in a general sense, denotes a cover for the head, in common use before the introduction of hats. See *HAT*.

Bonnets are still used in many parts of Scotland.

**BONNET**, in fortification, a small work, consisting of two faces, having only a parapet with two rows of palisadoes, of about ten or twelve feet distance: It is generally raised before the saliant angle of the counter-carp, and has a communication with the covered way, by a trench cut through the glacis, and palisadoes on each side.

**BONNET à pretre**, or *Priest's BONNET*, in fortification, VOL. I. No. 25.

is an out-work, having at the head three saliant angles, and two inwards. It differs from the double tenaille only in this, that its sides, instead of being parallel, are like the *queue d'aronde* or swallow's tail, that is, narrowing, or drawing close at the gorge, and opening at the head.

**BONNET**, in the sea-language, denotes an addition to a fail: Thus they say, *lace on the bonnet*, or *shake off the bonnet*.

**BONNEVILLE**, a town of Savoy, situated on the north side of the river Arve, about twenty miles south-east of Geneva, in 6° 10' E. long. and 46° 18' N. lat.

**BONNY**, among miners, a bed of ore, differing only from a squat as being round, whereas the squat is flat. See *SQUAT*.

**BONONIAN**. See *BOLONIAN*.

**BONOS-AYERES**. See *BUENOS-AYRES*.

**BONTIA**, in botany, a genus of the didynamia angiospermia class. The calix is divided into five pieces; the corolla is bilabiate, with the superior labium emarginated, and the inferior consists of three deep-cut segments; the berry, which is of the drupa kind, is oval, oblique at the apex, and contains but one plaited seed. The species are two, viz. the daphnoides and the germinata, both natives of the Indies.

**BONZES**, Indian priests, who, in order to distinguish themselves from the laity, wear a chaplet round their necks, consisting of an hundred beads, and carry a staff, at the end of which is a wooden bird. They live upon the alms of the people, and yet are very charitably disposed, maintaining several orphans and widows out of their own collections. The Tonquinese have a pagod, or temple, in each town, and every pagod has at least two bonzes belonging to it; some have thirty or forty. The bonzes of China are the priests of the Fohists, or sects of Fohi; and it is one of their established tenets, that there are rewards allotted for the righteous, and punishments for the wicked in the other world; and that there are various mansions, in which the souls of men will reside, according to their different degrees of merit. The bonzes of Pegu are generally gentlemen of the highest extraction.

**BOOK**, the general name of almost every literary composition; but, in a more limited sense, is applied only to such compositions as are large enough to make a volume. As to the origin of books or writing, those of Moses are undoubtedly the most ancient that are extant: But Moses himself cites many books that behaved to be wrote before his time. See *CHARACTER*.

Of profane books, the oldest extant are Homer's poems, which were so even in the time of Sextus Empiricus; though we find mention in Greek writers of seventy others prior to Homer; as Hermes, Orpheus, Daphne, Horus, Linus, Musæus, Palamedes, Zoroaster, &c.; but of the greater part of these there is not the least fragment remaining; and of others, the pieces which go under their names are generally held, by the learned, to be supposititious.

Several sorts of materials were used formerly in making

making books: Plates of lead and copper, the barks of trees, bricks, stone, and wood, were the first materials employed to engrave such things upon as men were willing to have transmitted to posterity. Josephus speaks of two columns, the one of stone, the other of brick, on which the children of Seth wrote their inventions and astronomical discoveries: Porphyry makes mention of some pillars, preserved in Crete, on which the ceremonies practised by the Corybantes in their sacrifices were recorded. Hesiod's works were originally written upon tables of lead, and deposited in the temple of the Muses, in Bœotia: The ten commandments, delivered to Moses, were written upon stone; and Solon's laws upon wooden planks. Tables of wood, box, and ivory, were common among the ancients: When of wood, they were frequently covered with wax, that people might write on them with more ease, or blot out what they had written. The leaves of the palm-tree were afterwards used instead of wooden planks, and the finest and thinnest part of the bark of such trees, as the lime, the ash, the mapple, and the elm; from hence comes the word *Liber*, which signifies the inner bark of the trees: and as these barks were rolled up, in order to be removed with greater ease, these rolls were called *volumen*, a volume; a name afterwards given to the like rolls of paper or parchment.

Thus we find books were first written on stones, witness the Decalogue given to Moses: Then on the parts of plants, as leaves chiefly of the palm-tree; the rind and barks, especially of the tilia, or phillyrea, and the Egyptian papyrus. By degrees wax, then leather, were introduced, especially the skins of goats and sheep, of which at length parchment was prepared: Then lead came into use; also linen, silk, horn, and lastly paper itself.

The first books were in the form of blocks and tables; but as flexible matter came to be wrote on, they found it more convenient to make their books in the form of rolls: These were composed of several sheets, fastened to each other, and rolled upon a stick, or *umbilicus*; the whole making a kind of column, or cylinder, which was to be managed by the *umbilicus* as a handle, it being reputed a crime to take hold of the roll itself: The outside of the volume was called *frons*; the ends of the *umbilicus*, *cornua*, which were usually carved, and adorned with silver, ivory, or even gold and precious stones: The title *σύλλαβη*, was struck on the outside; the whole volume, when extended, might make a yard and a half wide, and fifty long. The form which obtains among us is the square, composed of separate leaves; which was also known, though little used, by the ancients.

To the form of books belongs also the internal œconomy, as the order and arrangements of points and letters into lines and pages, with margins and other appurtenants: This has undergone many varieties; at first the letters were only divided into lines, then into separate words, which, by degrees, were noted with accents, and distributed, by points and stops, into periods, paragraphs, chapters, and other divisions. In some countries, as among the orientals, the lines began from the right and ran leftward; in others, as the northern and western nations, from left to right; others, as the Greeks, followed both directions, alternately going in the one, and returning in the other, called *boustrophedon*: In most countries, the lines run from one side to the other; in some, particularly the Chinese, from top to bottom. See COMPOSITION.

## B O O K - K E E P I N G .

**B**OOK-KEEPING is an art, teaching how to record and dispose the accounts of business, so as the true state of every part, and of the whole, may be easily and distinctly known.

Though the number and kinds of books used in this art be in some measure arbitrary, there are three which can never be dispensed with by those whose trade is complex or extensive, *viz.* the *Waste-book*, *Journal*, and *Ledger*.

### I. Of the WASTE-BOOK.

THE *Waste-book* is a register, containing an inventory of a merchant's effects and debts, with a record of all his transactions, narrated in a plain, simple style, and in the exact order of time as they succeed one another.

The *Waste-book* opens with the *inventory*; which consists of two parts: First, the *effects*, that is, the money a merchant has by him, the goods he has on hand, his share in ships, houses, farms, &c. with the debts due to him; the second part of the inventory is the debts due by him to others: The difference betwixt which and the effects, is what merchants call *net stock*. When a man begins trade, the inventory must be gathered from a survey of the particulars that make up his real estate; but must afterwards be collected from the balance of his old books, and carried to the new. This inventory is the first thing narrated in the *Waste-book*, as being the source and spring whence all subsequent transactions flow.

After the inventory is fairly narrated in the *Waste-book*, the transactions of trade come next to be jotted down;

down; which is a daily task, to be performed as they occur; and should be done distinctly, that is, every thing should be clearly and exactly expressed.

If no subsidiary books are kept, the Waste-book should contain a record of all the merchant's transactions and dealings in a way of trade; and that not only of such as are properly and purely mercantile, but of every occurrence that affects his stock, so as to impair or increase it; such as, private expences, servants fees, house-rents, money gained or lost on wagers, legacies, and the like. By such occurrences as these, a merchant as effectually becomes so much poorer or richer, as by the result of any branch of his trade. And the ends proposed in book-keeping can never be gained, if such things pass unrecorded.

II. Of the JOURNAL.

THE *Journal* is the book wherein the transactions recorded in the Waste-book are prepared to be carried to the Ledger, by having their proper debtors and creditors ascertained and pointed out.

One great design of the *Journal* is, to prevent errors in the Ledger; a thing of the worst consequence in book-keeping; which yet, without the help of this book, would be almost inevitable. For, suppose a person should attempt to form the *Debtors* and *Creditors* from the Waste-book in his mind, and at the same time post them to the Ledger, he shall find his thoughts so much embarrassed and over-charged, by attending at once to so many different things as occur here, that, were he an accomptant of very great experience, he could not well miss of falling into frequent blunders. This makes it necessary to divide the task, and do at twice what cannot be performed at once, without such hazard of mistakes; that is, first to write out the *Debtors* and *Creditors* in a separate book by themselves, and afterward transfer them to the Ledger. The work by this means being divided into parts, becomes more simple, and consequently more easy, and so may be performed with greater certainty of its being right. Again, after the Ledger is filled up, the *Journal* facilitates the work required in revising and correcting it; for, first the *Waste-book* and *Journal* are compared, and then the *Journal* and *Ledger*. Whereas, to revise and correct the Ledger immediately from the Waste-book, would be a matter of no less difficulty than to form it without the help of a *Journal*. Lastly, The *Journal* is designed as a fair record of a merchant's business: For neither of the other two books can serve this purpose; not the Ledger, by reason both of the order that obtains in it, and also on account of its brevity, being little more than a large Index. Nor can the Waste-book answer this design; for being written up in the time of business, and commonly too by different hands, it can neither be fair and uniform, nor very accurate.

The *Journal* is a kind of middle book betwixt the other two; it looks back to the one, and forward to the other. With the Waste-book it agrees in form, being ruled after the same manner. The order also and succession of things is the same in both. The thing then

that distinguisheth the two books is the style; that of the one being natural, and that of the other artificial. In the *Journal*, persons and things are charged *Debtors* to other persons or things as *Creditors*; and in this it agrees with the Ledger, where the same style is used, but differs from it as to form and order: So that it agrees with the Waste-book in those very things wherein it differs from the Ledger; and on the other hand, it agrees with the latter in that very point wherein it differs from the former.

But an example of the Waste-book turned into the *Journal* form, will give a clearer idea than can be conveyed by words.

WASTE-BOOK.

July 1st		l.	s.	d.
Bought	40 yards black cloth, at 14 s.	28	00	00
Bought of	James Sloan, 100 yards shalloon at 10 d.			
Whereof paid	— —	2	00	00
Rest due at two months	—	2	03	04
4 03 04				
4th		l.	s.	d.
Sold	William Pope 4 pipes Port-wine, at 27 l. 10 s.			
Whereof received	—	55	00	00
Rest due on demand	—	55	00	00
110 00 00				

JOURNAL.

July 1st		l.	s.	d.
Black Cloth	Dr to Cash 28 l.			
Paid for	40 yards, at 14 s.	—	—	28 00 00
Shalloon	Dr to Sundries 4 3 4	l.	s.	d.
To Cash,	in part for 100 yards, at 10 d.	2	00	00
To J. Sloan,	for the rest, at 2 months	2	03	04
4 03 04				
4th		l.	s.	d.
Sundries	Drs to Port Wine 110 l.			
Cash,	in part, for 4 pipes, at 27 l. 10 s.	55	00	00
Will. Pope,	for the rest on demand	55	00	00
110 00 00				

Before proceeding to give rules for writing in the *Journal*, it will be necessary to take notice, that every case or example of the Waste-book, when entered in the *Journal*, is called a *Journal post* or *entry*: Thus the examples above make up three distinct posts. Again, a post is either simple or complex. A *simple post* is that which has

has but one Debtor and one Creditor, as the first of these above. A *complex post* is either when one Debtor is balanced by two or more Creditors, as in the second post; or when two or more Debtors are balanced by one Creditor, as in the third post; or when several Debtors are balanced by several Creditors, and then the post is said to be complex in both its terms. This being premised, the rules to be observed are these following.

- I. In a simple post, the debtor is to be expressly mentioned, then the creditor, and, lastly, the sum, all in one line: After which follows the narrative, or reason of the entry, in one or more lines, as in the first of these three posts above.
- II. In a complex post, the several Debtors or Creditors are expressed in the first line, by Sundries, or Sundry Accounts, and the rest of the line filled up as in the

former rule. After which, the several Debtors or Creditors must be particularly mentioned, each in a line by themselves, with their respective sums subjoined to them; which are to be added up, and their total carried to the money-columns, as in the second and third posts.

The Journal, as described and exemplified above, is the form that was first in use among merchants; and is still the most common: but some make their Journal just a fair copy of the Waste-book, with the Debtors and Creditors written out on the margin, which is ruled large for that purpose. We shall here subjoin the three preceding posts done after this way; which, to one who understands the common method, will be sufficient instruction.

			July 11th.					
Dr Black Cloth,	l.	s.	d.	Bought 40 yards black cloth, at	l.	s.	d.	
Cr Cash,	28	00	00	14 s.	28	00	00	
Crs { Cash, -	2	00	00	Bought of James Sloan 100 yards				
{ J. Sloan,	2	03	04	shalloon, at 10 d.				
Dr Shalloon,	4	03	04	Whereof paid — — 2 00 00				
				Rest due at 2 mon. - 2 03 04				
					4	03	04	
				4th.				
Drs { Cash,	55	00	00	Sold Will Pope 4 pipes Port wine, at				
{ W. Pope,	55	00	00	27 l. 10 s.				
Cr Port Wine,	110	00	00	Whereof received — 55 00 00				
				Rest due on demand 55 00 00				
					110	00	00	

*Of the Terms DEBTOR and CREDITOR.*

The nature and use of the terms *Debtor* and *Creditor* will be obvious, from the considerations following.

I. Accounts in the Ledger consist of two parts, which in their own nature are directly opposed to, and the reverse of one another; which therefore are set fronting one another, on opposite sides of the same folio. Thus, all the articles of money received go to the left side of the Cash-account, and all the articles or sums laid out are carried to the right. In like manner, the purchase of goods is posted to the left side of the account of the said goods, and the sale, or disposal of them, to the right, &c.

II. Transactions of trade, or cases of the Waste-book, are also made up of two parts, which belong to different accounts, and to opposite sides of the Ledger: e. g. If goods are bought for ready money, the two parts are, the goods received and the money delivered; the former of which goes to the left side of the account of said goods, and the latter to the right side of the Cash-account.

III. These two different parts, in cases of the Waste-book, are not opposed to one another, as the two sides of the Ledger-accounts are; but, on the contrary, have

a mutual connection and dependence, the one being the ground, condition, or cause of the other. Thus, in the preceding example, when goods are bought for ready money, the receipt of the goods is the cause of parting with the money; and, on the other hand, the delivering of the money is the condition on which the goods are received.

From these three observations, it is plain, that, in order to post a case of the Waste-book to the Ledger, the first thing the accountant must do, is, to divide the case into its parts, and then to think with himself, to which account, and to what side, each of these parts is to be carried; and when the entry is actually made, the connection of the parts with one another must be expressed in each of the accounts to which they are transported. Now, since in speaking and writing things must have names whereby they may be expressed and written, it is necessary that two words or terms be contrived, and appropriated to these two different parts, that have the same relation to one another as the parts themselves have, which may at once characterise and distinguish the parts from one another, point out and ascertain to what side of the Ledger each of them is to be carried, and withal express their relation to, and dependence upon one another.

The Italians at first for this purpose pitched upon the terms

terms Debtor and Creditor, because their common acceptation comes nearer to the thing here meant than any other they could think on. By means of these terms, the two parts, in any case of the Waste-book, when posted to the Journal, are denominated, the one the *Debtor*, and the other the *Creditor*, of that post. And when carried from thence to the Ledger, the Debtor, or Debtor part, is entered upon the left side (hence called the *Debtor-side*) of its own account, where it is charged *Debtor* to the *Creditor part*; Again, the Creditor, or Creditor part, is posted to the right side, or Creditor-side of its account, and made *Creditor* by the *Debtor part*. Hence Italian book-keeping is said to be a method of keeping accounts by double entry, because every single case of the Waste-book requires at least two entries in the Ledger, *viz.* one for the Debtor, and another for the Creditor.

We shall illustrate what has been said by two examples. *First*, Suppose a merchant buys a pipe of wine for ready money, the two parts in this case are, the wine received, and the money delivered for it, which are characterized by the terms *Debtor* and *Creditor* in the Journal-post thus: *Wine Dr to Cash*; where the meaning is, (though to express it so is needless), that as *Wine* is Dr to *Cash*, so *Cash* is Cr by *Wine*. And accordingly when carried to the Ledger, the *Wine-account* is charged Dr to *Cash*, and the *Cash-account* is made Cr by *Wine*. Again, *2dly*, Admit the merchant sells this pipe of wine for present money, in this case the two parts are the same as before; but when clothed with Debtor and Creditor, will stand inverted thus: *Cash Dr to Wine*. And accordingly, in the Ledger, the *Cash-account* is charged Dr to *Wine*, and the *Wine-account* gets credit by *Cash*. From all which it is evident, the terms *Debtor* and *Creditor* are nothing else but marks or characteristics stamped upon the different parts of transactions in the Journal, expressing the relation of these parts to one another, and shewing to which side of their respective accounts in the Ledger they are to be carried.

**RULES relating to Debtor and Creditor.**

- I. A thing received upon trust, is Dr to the person of whom it is received.
  - II. The person to whom a thing is delivered upon trust, is Dr to the thing delivered.
  - III. A thing received, is Dr to the thing given for it.
  - IV. In antecedent and subsequent cases, parts that are the reverse of one another in the nature of the thing, are also opposed in respect of terms.
  - V. In cases where personal and real Drs or Crs are wanting, the defect must be supplied by fictitious ones.
  - VI. In complex cases, the sundry Drs or Crs are to be made out from the preceding rules jointly taken.
- We now proceed to the particular application of *Debtor* and *Creditor* in the several branches of trade, *viz.*
- I. *Proper trade*, which a merchant carries on for himself.
  - II. *Factorage*, which he manages for another, called his *Employer*.
  - III. *Partnership*, which is carried on by a trustee, in name of all the partners.

**1. IN PROPER TRADE.**

**PROPER** trade is either domestic or foreign. *Proper domestic trade*, is that which a merchant carries on by himself, without the help of a factor. *Proper foreign trade*, is the business that occurs to a merchant by employing a factor.

*1st, Debtor and Creditor applied in proper domestic trade.*

**PROPER** domestic trade, comprehends the *inventory*, *buyings*, *selling*, *bartering*, *receiving money*, and *paying money*. To each of these we shall assign a distinct problem; and, to prevent burdning the learner's memory, we shall deliver the several cases as compendiously as possible, subjoining to each problem such notes as seem necessary for clearing any thing that requires farther illustration.

N. B. As we refer from the cases and notes of each problem, to the examples of the *Waste-book* and *Journal*, by the dates; so we have made use of letters and numbers, as references from them to the cases and notes of the problems, which the reader will easily observe.

**Prob. 1. A. Debtor and Creditor applied to the inventory.**

The *inventory* consists of two parts, and accordingly is journalized at twice, *viz.* 1. *Sundries Drs to Stock*. The several Drs are, *Cash*, for the merchant's ready money; *Goods on hand*, for their respective values; *Persons*, for their debts due to him. 2. *Stock Dr to Sundries*. The several Crs are, the persons to whom the merchant owes. Compare the *Waste-book* and *Journal*, Jan. 1.

Note, Stock is a fictitious term used instead of the merchant's name.

**Prob. 2. B. Debtor and Creditor applied in buying:**

In buying one single commodity, there are seven distinct cases, (*viz.* three simple, and four complex): in all which the goods bought and received are Dr; but the Cr varies according to the terms of purchase.

*Case 1.* When goods are bought for ready money, the entry is, *Goods bought Dr to Cash*. Jan. 6.

2. When goods are bought, and paid for by giving the feller a bill or note upon a third person, *Goods bought Dr to the Acceptor*, *viz.* the said third person.

3. When goods are bought on time, *Goods bought Dr to the Seller*. Jan. 10. Oct. 21.

4. When goods are bought for part money, part bill.

*Goods bought Dr to Sundries, viz.*

*To Cash*, for the sum paid,

*To Acceptor*, for value of the bill.

5. When goods are bought for part money, part on time.

*Goods bought Dr to Sundries, viz.*

*To Cash*, paid in part, *Jan. 15.*

*To Seller*, for the rest.

6. When goods are bought for part bill, part time.

*Goods bought Dr to Sundries, viz.*

*To Acceptor*, for value of the bill,

*To Seller*, for the rest.

7. When goods are bought for part money, part bill, part time,

*Goods bought Dr to Sundries, viz.*

*To Cash*, for the sum paid,

To *Acceptor*, for value of the bill,  
To *Seller*, for the rest. Feb. 2.

*Note 1.* When two or more kinds of goods are bought from one person at the same time, there will be two or more *Drs*, viz. the several kinds of goods bought, each for their value. And the same variety of cases will occur here as when one single commodity is bought; so that, if the sundry goods be bought for ready money, or on bill, or on time, the entry will be,

*Sundries Drs*, { To *Cash*, if bought for ready money. Feb. 16.  
                  { To *Acceptor*, if on bill,  
                  { To *Seller*, if on time.

But if the sundry goods are bought for part money, part bill, or for part money, part time, or for part bill, part time, &c. it is best to resolve the case into two entries, viz. First charge the *Goods* Dr to the *Seller*, for their full value, as if they had been bought on time; and then make the *Seller* Dr to *Cash*, or to the *Acceptor*, or to both, (as the nature of the case is), for the part paid. Thus, suppose the goods are bought for part money, part bill, part time, the two entries will be,

1. *Sundries* Drs to the *Seller*, for the respective values of the goods.  
2. *Seller*, Dr to *Sundries*, viz.  
    To *Cash*, for the sum paid,  
    To *Acceptor*, for value of the bill.

*Note 2.* If you buy goods to be received some time afterward; and, in prospect of this, advance some part of the price to the seller: in this case, charge the *Seller* Dr to *Cash*, for the sum advanced; and when you receive the goods, make them Dr to the seller, for their full value. Or if immediately upon receiving them you clear with the seller, then make *Goods* received Dr to *Sundries*, viz. to the *Seller*, for the sum formerly advanced; and to *Cash*, for the sum now paid. In bargains of this nature, there is commonly a penalty agreed on to be paid by the seller in case of non-performance. Now, if in this case the seller happen to fail, you the buyer, upon receiving payment of the advanced money and penalty, enter *Cash* Dr to *Sundries*, viz. to the *Seller*, for the sum advanced, and now recovered, and to *Profit and Loss*, for the penalty: or, instead of using the general account, *Profit and Loss*, you may erect in the *Debit* an account, under the title of *Refusal of bargain*, which is to be made *Debit* for all the penalties of this nature you pay, and get *Credit* for all you receive. May 13. If you buy goods to be received afterwards, without advancing any part of the price; it is sufficient to take a note of them in a pocket-book; and when you receive them, they are booked as goods presently bought.

Prob. 3. C. Debtor and Creditor applied in selling.

Selling is just the reverse of buying, and has the same variety of cases, viz. seven; whereof three are simple, and four complex: in all which, the goods sold and delivered are Cr; but the Dr varies according to the conditions of sale.

*Case 1.* When goods are sold for ready money, the entry is, *Cash* Dr to *Goods* sold. Feb. 25.

2. When goods are sold on bill or note, *Acceptor* Dr to *Goods* sold. March 17. See *Note 1.*

3. When goods are sold on time, *Buyer* Dr to *Goods* sold. March 1.

4. When goods are sold for part money, part bill, *Sundries* Drs to *Goods* sold, viz.  
*Cash*, for the sum received.  
*Acceptor*, for value of the bill. March 22.

5. When goods are sold for part money, part on time, *Sundries* Drs to *Goods* sold, viz.  
*Cash*, received in part,  
*Buyer*, for the rest. March 4.

6. When goods are sold for part bill, part time, *Sundries* Drs to *Goods* sold, viz.  
*Acceptor*, for value of the bill,  
*Buyer*, for the rest.

7. When goods are sold for part money, part bill, part time, *Sundries* Drs to *Goods* sold, viz.  
*Cash*, for the sum received,  
*Acceptor*, for value of the bill,  
*Buyer*, for the rest.

*Note 1.* Thus the entries in buying and selling one single commodity are just the reverse of one another: and this also holds in buying and selling two or more kinds of goods; which we shall therefore pass, referring the learner to the cases of buying in the preceding problem.

*Note 2.* If you sell goods to be delivered, not presently, but some time afterward, and receive money *per advance*, charge *Cash* Dr to the *Buyer*, for the sum received; and when you deliver the goods, charge the *Buyer* Dr to *Sold Goods*, for their full value. But if, upon delivery of the goods, you immediately receive the remaining part of their price, enter *Sundries* (viz. the *Buyer*, for the sum received *per advance*, and *Cash*, for the sum now received) Drs to the *Goods* delivered. If you find you cannot perform the bargain, and be oblig-

ged to return the money advanced, and pay the penalty, make *Sundries* (viz. the *Buyer*, for the sum advanced, and *Profit and Loss*, or *Refusal of bargain*, for the penalty) Drs to *Cash* now paid.

*Note 3.* If you sell a ship, house, &c. enter *Cash*, or the *Buyer*, Dr to *Sold Ship* or *House*, for the price they are sold at.

*Note 4.* If you send goods to *A. B.* and leave it to his choice, whether to keep or return them, erect an account under the title of *Suspense-account*, and charge it Dr to the goods sent off. If the goods be returned, reverse the former entry. If he keep them, charge *A. B.* Dr to *Suspense-account*, for the value of the goods sent him. If he sends up the price, charge *Cash* Dr to *Suspense-account*. May 7. June 16.

Prob. 4. D. Debtor and Creditor applied in bartering.

Barter, or the exchanging of goods for goods, is nothing else but buying and selling blended together; the cases of which, if the goods received and delivered be of equal value, are these four.

*Case 1.* When one commodity is received for another delivered, enter *Wares* received Dr to *Wares* delivered. April 10.

2. When one commodity is received for two or more delivered, enter *Wares* received Dr to *Sundries*, viz. to the several *wares* delivered, for their respective values.

3. When two or more sorts of wares are received for one delivered, enter *Sundries* (viz. the several *wares* received, each for their value) Drs to *Wares* delivered. April 16.

4. When several wares are bartered with *A. B.* for several, make two entries, and that whether the wares received and delivered be of equal value or not.

1. *A. B.* Dr to *Sundries*, viz. to each sort delivered, for their respective values.  
2. *Sundries* (viz. each sort received, for their respective values) Drs to *A. B.* April 30.

*Note 1.* Supposing the goods received and delivered are not in themselves of equal value, but that the deficiency is made up by money or bill, or the one merchant gives the other credit for the difference: upon this supposition there will be several other cases; such as, 1. *Wares* received, for part wares, part money. 2. For part wares, part bill. 3. Part wares, part time. 4. Part wares, part money, part time, &c. In all which cases, the *Wares* received are Dr to *Sundries*. The particular Drs in each case are as follows.

*Case 1.* { To *Wares* delivered, for their value,  
          { To *Cash*, for the sum paid.  
2. { To *Wares* delivered, for their value,  
          { To *Acceptor*, for the bill.  
3. { To *Wares* delivered, for their value,  
          { To *dealer*, for the rest.  
4. { To *Wares* delivered, for their value,  
          { To *Cash*, for the sum paid,  
          { To *Dealer*, for the rest.

*Note 2.* On the other hand, wares in barter may go off, or be delivered, 1. For part wares, part money. 2. For part wares, part bill. 3. Part wares, part time. 4. Part wares, part money, part time, &c. In all which cases, *Sundries* are Dr to the *Wares* delivered. The particular Drs in each case are the same with the Drs in the cases immediately preceding, as follows.

*Case 1.* { *Wares* received for their value,  
          { *Cash*, for the sum received. April 22.  
2. { *Wares* received, for their value,  
          { *Acceptor*, for the bill.  
3. { *Wares* received, for their value,  
          { *Dealer*, for the rest.  
4. { *Wares* received, for their value,  
          { *Cash*, for the sum received,  
          { *Dealer*, for the rest.

Prob. 5. E. Debtor and Creditor applied in receiving money.

In all cases of this nature, *Cash* is Dr; but the Cr varies, according to the terms on which the money is received.

*Case*



Case 1. When you receive money for goods presently sold, the entry, as already mentioned in the first case of selling, is, *Cash Dr to Goods* sold, for their value. *Feb 25.*

2. When you borrow, or take up money at interest, enter *Cash Dr to the Lender*, for the sum received, mentioning the rate of interest, and time of payment.

3. When you get money, whether as payment of a debt, or taken up at interest, and receive it, not from the debtor or lender, but upon his assignation from a third person, enter *Cash Dr to the Assigner*, not to him that pays it.

4. When you receive money, as payment of goods formerly sold, or in payment of an accepted bill or note, or any other debt, where neither discount nor interest is allowed, enter *Cash Dr to the Payer*, for the sum received, mentioning whether in full or in part. *Feb. 5. March 23. April 6. July 30. Aug. 3. Nov. 12.*

5. When you receive money, as payment of an accepted bill or note, or any other debt, (except for goods formerly sold), *per advance*, and upon that account allow discount, or abatement on any other consideration, enter *Sundries Drs to the Payer, viz.*

*Cash*, for the sum received,  
*Profit and Loss*, for the sum discounted or abated.  
*Nov. 12.*

6. When, in receiving payment for goods formerly sold, you allow discount or abatement; if the account of said goods be closed in the *Ledger*, enter as in the last case: but if the said account be yet open, enter thus, *Sundries Drs to the Buyer, viz.*

*Cash*, for the sum received,  
*Goods*, for the sum discounted or abated. *April 1.*

7. When you receive money, as interest of a sum formerly lent, the principal being continued, enter *Cash Dr to Profit and Loss*, or to *Interest account*, for the sum received. *Sept. 10.*

8. When you receive both principal and interest, enter *Cash Dr to Sundries, viz.*

*To the Borrower*, for the principal,  
*To Profit and Loss*, or to *Interest-account*, for the interest *Nov. 8.*

9. When you receive money as the premium for insuring another man's ship or goods at sea, enter *Cash Dr to Insurance account*, or to *Profit and Loss*.

10. When you receive money as the price of a ship, house, or estate, presently sold, or as the freight, or the rent of them, supposing the hiring out of the ship, or setting of the house, &c. not to be booked, enter *Cash Dr to such a Ship, House, or Estate. Sept. 1.*

11. But if the hiring out of the ship, house, or estate, was formerly booked, the entry for money received as freight or rent will be, *Cash Dr to the Freighter or Tenant.*

12. When you receive money, in legacy or compliment, or with an apprentice, or as gained on a wager, or by exchange of money, &c. for which nothing goes out, enter *Cash Dr to Profit and Loss*, or to *Stock*

*Notes.* It commonly happens that legacies are not paid presently, and in this case you must charge the executor *A. B. Dr to Profit and Loss*, till you receive payment; and then discharge him by *Cash*, or the thing received. *June 3.*

Prob. 6. F. Debtor and Creditor applied in paying money.

In all cases of this nature, *Cash* is Cr; but the Dr va-

ries, according to the terms on which the money is delivered.

Case 1. When you pay money for goods presently bought, the entry (as already stated in the first case of buying) is, *Goods bought Dr to Cash*, for the sum paid. *Jan. 6.*

2. When you lend or give out money at interest, enter the *Borrower Dr to Cash*, for the principal, mentioning the rate of interest, and time of payment. *March 10. August 6.*

3. When, by order of your creditor, you pay money to any person, enter the *Assigner* (not the *Assignee*) *Dr to Cash*, for the sum paid.

4. When you pay for goods formerly bought, or pay an accepted bill or note, or any other debt, where neither discount nor interest is allowed; enter the *Receiver Dr to Cash*, for the sum paid, mentioning whether in full or in part. *Jan. 15. Jan. 30. March 10. and 23. May 3. June 8. June 22. and 29.*

5. When you pay an accepted bill or note, or any other debt, (except for goods formerly bought), *per advance*, and upon that account have discount allowed you, or abatement on any other consideration; enter *Receiver Dr to Sundries, viz.*

*To Cash*, for the sum paid,  
*To Profit and Loss*, for the sum discounted.

6. When, in paying for goods formerly bought, you have discount or abatement allowed; if the account of said goods in the *Ledger* be closed, enter as in the last case; but if the said account be yet open, enter thus, *Receiver Dr to Sundries, viz.*

*To Cash*, for the sum paid,  
*To Goods*, for the sum discounted or abated.

7. When you pay the interest of a sum formerly borrowed, the principal being continued in your own hand; enter *Profit and Loss*, or *Interest-account*, *Dr to Cash*, for the sum paid.

8. When you pay both principal and interest, enter *Sundries Drs to Cash, viz.*

*Lender*, for the principal,  
*Profit and Loss*, or *Interest-account*, for the interest.

9. When a ship or goods you have formerly insured happens to be lost, and thereupon you pay the value to the owners, enter *Insurance-account Dr to Cash*, for the sum paid.

10. When you pay for a ship, house, or estate, presently bought; or pay repairs, taxes, or other charges on them: enter *Ship, House, or Estate, Dr to Cash*, for the sum paid.

11. When you pay charges on goods, as freight portage, &c. enter *Goods Dr to Cash*, for the sum paid.

12. When you pay charges that relate to trade in general, such as warehouse rent, shop-rent, shop keepers wages, postage of letters, &c. enter *Charges of merchandise Dr to Cash. July 2. July 5.*

13. When you pay your landlord rent for a dwelling-house, servants their wages, or make any disbursements for yourself or family; as all expenses of this nature should be collected in a small book by themselves; so, when you bring them to the *Journal*, enter thus: *House-expences Dr to Cash*, for the total. *Nov. 11. Dec. 30.*

# (\*A) B O O K - K E E P I N G.

14. When you pay upon losing a wager; or when you lose upon exchange, that is, put off a piece of coin for less than it cost you; or when you give away money in charity, or any other way not yet mentioned, for which nothing comes in; enter *Profit and Loss* Dr to *Cash*, *Oct.* 22.

*Note 1.* An assignment differs as to its nature and form from a bill or note; but the *Journal* entries is the same with respect to all of them. In an assignment there are three persons concerned: 1. He who gives the assignment, called the *Assigner*. 2. He on whom the assignment is given, or by whom it is payable, called the *Assignee*. 3. He to whom it is payable, called the *Assignee*. Here we shall propose two or three cases not yet taken notice of. 1. Suppose you pay a debt to *Samuel Neady*, by an assignment on *Peter Pundual*, the entry is, *Samuel Neady* Dr to *Peter Pundual*. 2. If *A. B.* give an assignment or bill on you to *M. S.*, which you do not pay presently; in this case, charge *A. B.* Dr to *M. S.* 3. If *F. R.* give you an assignment or bill on *G. H.* which he does not pay presently, charge *G. H.* Dr to *F. R.* 4. If *Y. H.* draw a bill on you to *G. L.* payable against a certain day, which you pay presently, upon having discount allowed you; in this case, make *Y. H.* Dr to *Sundries*, *viz.* to *Cash*, for the sum paid, and to *Profit and Loss*, for the sum discounted.

*Note 2.* If you pay a debt with goods, instead of money, the goods delivered, and not *Cash*, will be Cr. As, 1. If you pay *A. B.* in goods, for goods formerly bought, or for a bill you have formerly accepted, and that whether in full or in part, enter *A. B.* Dr to the *Goods*, for their value. 2. If you pay him on the same account, part goods, part money, charge *A. B.* Dr to *Sundries*, *viz.* to *Goods*, for their value, and to *Cash*, for the rest. 3. If you give him goods above the debt, and he presently pay you back the balance in money, enter *Sundries* *viz.* *A. B.* for the sum of the debt, and *Cash*, for the balance) Dr to *Goods*, for their full value. 4. If you give him goods above the debt, but do not presently receive the balance, enter simply *A. B.* Dr to *Goods* delivered, for their value. 5. If you pay interest of a bond, or sum borrowed, with goods, charge *Profit and Loss* Dr to the *Goods* delivered, &c.

*Note 3.* To prevent filling up your *Ledger* with accounts for every small dealer, you may erect a general account, under the title of *Debit General*, and charge it Dr for all his petty debts, mentioning in each entry the account to which, the person's name, and sum; and give it credit for all the payments, expressing also the accounts by which, with the persons names, and sums of money. To this credit-side also carry all such small debts you owe, and debit the account as you pay. Or, if you incline to be more distinct, erect two general accounts; one called *Debit receivable*, and the other *Debit payable*. Charge the former with all the petty debts due to you, and give it credit as you receive payment. Make the latter Cr for all the small debts due by you to others, and charge it Dr as you pay.

*Note 4.* In like manner, to have the labour of opening an account in the *Ledger* for every person you may have a bill upon, or who may have one on you, erect two general accounts; one, by the title of *Bills receivable*, and the other, *Bills payable*; and charge the former Dr for all the bills accepted, and payable to you, and give it credit as you receive payment. *March* 17. and 23. Make the latter Cr for all the bills you accept, and charge it Dr as you pay. *Sep.* 3. *Sep.* 10.

*N. B.* If the person have an account already opened in your *Ledger*, or if you have the prospect of dealing with him in other things for the future, you are not to use these general accounts.

*Note 5.* The entries mentioned in this and the preceding problem, with respect to wagers, suppose, that the wager is gained or lost, and the bet paid, before the wager is booked; which is indeed the best way, if the wager is very soon to be determined. But if you enter into a wager that cannot be soon decided, and thereupon consign the bets in a third person's hands; in this case, it is proper to erect an account under the title of *Wagers account*, and charge it Dr to *Cash*, for the sum consigned. If you gain the wager, and receive the bets, enter *Cash* Dr to *Wagers account*, for the sum received; if you lose, make *Profit and Loss* Dr to *Wagers account*, for the sum formerly consigned, and now lost. Sometimes the bets are consigned in one of the parties hands. Thus, in *April* 1734, two gentlemen in *London* entered into a wager concerning the reduction of *Danzick* by the *Russians*; whereupon one of them consigned 100 guineas in the other's hands, upon condition that he should pay him three guineas a-day till the city should be taken or surrendered. In this case, if you receive the 100 guineas, enter *Cash* Dr to *Wagers account*; and when the wager is determined, make *Wagers account* Dr to *Cash*, for all you pay back. If you consign the 100 guineas, charge *Wagers account* Dr to *Cash*; and when the wager is decided, make *Cash* Dr to *Wagers account*, for all you receive back.

*Note 6.* These accounts, *viz.* *Refusal of bargains*, *Interest*, *Entomry*, *Insurance*, *Bank expenses*, are of the same nature with the general account *Profit and Loss*, being nothing else but particular branches of it; and the only design of keeping them distinct is, in order to know what is gained or lost on each of these several heads.

*Note 7.* When a ship or goods you have insured to another happens to be lost at sea, and thereupon you pay the value; after this the subject lost becomes your own; and if any of the wreck be recovered, enter the Thing recovered Dr to *Insurance account*, for its value, and charge *Insurance account* Dr to *Cash*, for what you expend in search of it.

*Note 8.* If you have frequent occasion to deal in outlandish money, or pieces not current, you may erect an account under the title of *Foreign coin*, or, particularly, *Spanish coin*, &c. and charge it Dr or what pieces you receive, and give it credit as you put them off. *March* 21. *March* 23.

*Note 9.* If any parcel of goods happen to be damaged or lost, or liquor to be spilled, &c. charge *Profit and Loss* Dr to the *Account of the goods or liquor*, for the value of the damage, loss, or of the quantity spilled, &c.

*Note 10.* We shall now conclude proper domestic trade, by reminding the learner, in posting any case to the *Journal*, carefully to consider, whether it be opposed in any of its parts to some preceding one; otherwise no rules, however particular, can be sufficient to direct his practice. For if the parts of a former and subsequent case be the reverse of one another, they must also be opposed in respect of terms, notwithstanding whatever particular rules may seem to say. Thus, suppose *A. B.* accepts a bill payable to you, and thereupon you charge, not *A. B.* but the general account *Bills receivable* Dr; it is plain, that when you receive payment, you must enter *Cash* Dr, not to *A. B.* but to *Bills receivable*, notwithstanding what is said, *prob.* 5. *case* 4.

See *March* 17. and 23. Again, admit you accept a bill payable to *A. B.* and thereupon credit, not *A. B.* but the general account *Bills payable*; it is evident, that when you pay, you must charge, not *A. B.* but *Bills payable*, Dr to *Cash*, notwithstanding *prob.* 6. *case* 4. See *Sept.* 3. and 10.

2dly, Debtor and Creditor applied in proper foreign trade.

Proper foreign trade comprehends, 1. The shipping of goods to a factor. 2. Advices concerning them from the factor. 3. Returns made by the factor to you.

*Prob.* 1. G. Debtor and Creditor applied in shipping of goods to a factor.

In all cases, *voyage to* — is Dr; but the Cr. varies, according as the goods shipped off are already entered in your books, or presently bought; and that again, either for ready money, or on time, &c.

*Case* 1. If you ship off goods which are already entered in your books, enter

*Voyage* Dr to *Sundries*, *viz.*

To the respective *Goods*, for their value,

To *Cash*, for custom, insurance, and all other charges.

2. If you buy a cargo for ready money, and ship it off immediately, without entering the purchase in your books, enter *Voyage* Dr to *Cash*, for prime cost, and all charges.

3. If you buy goods on time, and ship them off, without entering them in your books, enter

*Voyage* Dr to *Sundries*, *viz.*

To *Seller*, or *Sellers*, for value of the goods,

To *Cash*, for charges at shipping.

4. If you ship off a cargo, made up partly of goods taken from your own warehouse, partly of goods bought, on time, enter

*Voyage* Dr to *Sundries*, *viz.*

To *Goods* your own, for their value,

To *Seller* or *Sellers*, for value of the goods bought,

To *Cash*, for all charges. *Jan.* 21.

*Note 1.* Several other cases may be supposed; such as, 1. When the cargo consists of goods, part your own, part bought for ready money. Or, 2. Part your own, the rest bought, part for ready money, part on time. *July* 21. Or, 3. All bought, part for ready money, part on time. Or, 4. Part your own, part bought, part immediately received in barter, or as payment of a debt. But the way of journalising these and the like cases, may be easily gathered from what is already said; and therefore we shall leave them for the learner's exercise.

*Note 2.* If you do not pay charges at shipping immediately, you must credit the *Person* to whom it is due, and not *Cash*; or, if you please, erect a general account, under the title of *Debit payable*, or *Charges payable*, and charge *Voyage* Dr to it, and as you pay enter it Dr to *Cash*.

*Note 3.* As *Voyage* is to be debited for all charges, or whatever augments the cost; so it must be credited by whatever lessens the same, such as drawbacks on re-exported goods. *Sept.* 28.

*Note 4.* Instead of the title, *Voyage to* —, some use *Adventure to* —, or *Adventure to* — per such a ship; as, *Adventure to Barbadoes per the Neptune*.

*Prob.* 2. H. I. Debtor and Creditor applied, upon advice from your factor, A. B.

H. § 1. The cases of the first advice.

In all cases of the first advice, *Voyage to* — is Cr; but the Dr varies, according to the nature of the advice.

*Case* 1. If the first advice be, That *A. B.* has received your goods, but sold none of them, enter *A. B.* my account of goods. Dr to *Voyage*, for the sum the said voyage was formerly charged with.

2. If the first advice be, That *A. B.* has received the goods, and sold them for ready money, enter *A. B.* my account current Dr to *Voyage*, for the neat proceeds; that is, the sum due to you, after the factor's commission and all charges are deducted. *Sep.* 22.

3. If

3. If the first advice be, That the goods are received, and all sold on time, enter *A. B. my account on time* Dr to *Voyage*, for the neat proceeds.

4. If the first advice be, That they are received, and all sold, part for ready money, part on time, enter *Sundries* Drs to *Voyage*, viz.

*A. B. my account current*, for the money in his hands,

*A. B. my account on time*, for the debts outstanding.

5. If the first advice be, That the goods are not only received and sold, but a cargo shipped in return, and now at sea; here there are three varieties. 1. If the value of the cargo inward, with charges paid by the factor, be equal to the neat proceeds, enter *Voyage* inward Dr to *Voyage* outward, for the neat proceeds. 2. If the factor overrip the neat proceeds, enter *Voyage* inward Dr to *Sundries*, viz. to *Voyage* outward, for the neat proceeds, and to *Factor my account-current*, for the rest. 3. If he underrip the neat proceeds, enter *Sundries* (viz. *Voyage* inward, for its value, and *A. B. my account-current*, for the rest) Drs to *Voyage* outward. June 18.

6. If the first advice be, whether from the factor or any body else, That the ship and cargo is lost at sea, there will be also three varieties. 1. If the goods lost were not insured, enter *Profit and Loss* Dr to *Voyage*, for the whole value. 2. If the goods lost were all insured, charge the *Insurer*, or *Cash*, if you get present payment, Dr to *Voyage*. 3. If part of the goods only were insured, make *Sundries* (viz. the *Insurer*, or *Cash*, for the value insured, and *Profit and Loss*, for the rest) Drs to *Voyage*, for the whole loss.

I. § 2. *The cases of the second advice.*

In journalizing a second or third advice, respect must be had to the entry that was made upon the advice immediately preceding; for whatever was then Dr, must be now made Cr. And therefore, supposing the first or former advice was, That the factor had received the goods, but sold none of them, the entry to be made upon a second advice will be as in the cases following

*Case 1.* If the second advice be, That the goods formerly received are now sold, in whole or in part, for ready money, enter *A. B. my account current* Dr to *ditto my account of goods*, for neat proceeds

2. If the second advice be, That goods received formerly are now sold in whole or in part, on time, enter *A. B. my account on time* Dr to *ditto my account of goods*, for neat proceeds.

3. If the second advice be, That goods formerly received are now old, part for ready money, part on time, enter *Sundries* Drs to *A. B. my account of goods*, viz.

*A. B. my account-current*, for the money in his hands.

*A. B. my account on time*, for the outstanding debts.

But if the former advice had been, That the factor had sold your goods on time, then, upon this supposition, the advice that comes next, whether second or third, is journalized as follows.

*Case 1.* If the next advice be, That the factor has now received payment of the debts outstanding, enter *A. B. my account-current* Dr to *ditto my account on time*, for the sum received by him.

2. If the next advice be, That he has indeed received payment of the debts, but was obliged to allow abatement, for inlack of goods, or for other reasons, enter *Sundries* Drs to *A. B. my account on time*, viz.

*A. B. my account-current*, for the sum received by him,

*Profit and Loss*, for the sum abated.

Prob. 3. K. L. Debtor and Creditor applied, when returns are made you by the factor.

Returns are made in goods or bills.

K. § 1. *The cases of returns in goods.*

*Case 1.* If the factor ship off, and consign goods to yourself, advising you thereof by post, before the arrival of the ship, enter *Voyage* from——Dr to *A. B. my account-current*, for cost and charges of the cargo, as per factor's invoice.

2. If the factor ship off goods for yourself, of which you have no advice, or of which you book no advice, prior to the arrival of the ship, enter

*Goods received* Dr to *Sundries*, viz.

To *A. B. my account-current*, for cost and charges, as per invoice,

To *Cash*, for new charges paid here.

3. If your factor *A. B.* at *Leghorn* ship off goods not to yourself, but, by your order, to *C. D.* your factor at *Lisbon*, and advise you thereof, by sending you a copy of the invoice, enter *Voyage from Leghorn to Lisbon* Dr to *A. B. my account current*, for cost and charges, as per invoice.

*Note 1.* The entries in this problem suppose that you have received the account of sales, and debited the account current, for neat proceeds; which naturally leads to give the account-current credit here, and shows how the Dr part of a prior entry is reversed, or become Cr in a posterior one.

*Note 2.* There are two or three cases relative to those mentioned, which we shall here take notice of. 1. When the ship and cargo mentioned in *case 1.* arrives, you enter *Goods received* Dr to *Sundries*, viz. to *Voyage* hither, for what it was charged with, and to *Cash*, for charges paid here. Or, if you please, first charge *Voyage* Dr to *Cash*, for charges, see July 9.; and then discharge the *Voyage* by the *Goods*, see July 10. Or, if you dispose of all or any part of the cargo on the key, viz. before the voyage be discharged in your books, enter the *Buyer*, or *Cash*, or *Thing received*, Dr to the *Voyage*. See July 9. 2. If the said ship and cargo should happen to be lost at sea, then if the goods be not insured, you enter *Profit and Loss* Dr to *Voyage* inward, for what it was charged with. But if the cargo be insured, charge the *Insurer*, or *Cash* if you get present payment, Dr to *Voyage*, &c. 3. If a cargo consigned to you happen to be lost at sea, which you have notice of before any entry is made in your Books; in this case, enter *Profit and Loss*, the *Insurer*, or *Cash*, Dr to *A. B. my account-current*, for the value lost.

L. § 2. *The cases of returns in bills.*

*Case 1.* If you draw upon your factor, and receive present money for the bill, enter *Cash* Dr to *A. B. my account-current*, for value of the bill.

2. If you draw upon your factor, and give the remitter a day for payment; or if you owe the remitter, and give him the bill as payment; enter the *Remitter* Dr to *A. B. my account-current*, for the value of the bill July 15.

3. If you draw upon your factor *A. B.* payable to your factor *C. D.* charge *C. D. my account-current* Dr to *A. B. my account-current*, for value of the bill.

4. If your factor remit you a bill, for which you receive present payment, enter *Cash* Dr to *A. B. my account current*, for the value of the bill.

5. If your factor remit you a bill, payable at single or double usance, or any other time after date or sight; upon getting the bill accepted, enter *Bills receivable* Dr to *A. B. my account-current*, for value of the bill. Sept. 30.

(B\*) B O O K - K E E P I N G.

6. If your factor A. B. by your order, remit a bill to your factor C. D. charge C. D. my account-current Dr to A. B. my account-current, for value of the bill.

2. IN FACTORAGE.

FACTORAGE comprehends three things: 1. The receipt of the employer's goods. 2. The disposal of them. 3. Returns made for them.

Prob. 1. M. Debtor and Creditor applied upon the receipt of goods.

WHEN you turn factor, and have goods consigned to you by your employer; upon receiving the goods, enter A. B. his account of goods Dr to Cash, for freight, custom, or other charges you pay. Aug. 10.

Note 1. If there be but one kind of goods, name it; as, A. B. his account of serges. A. B. his account of sugar, &c.

Note 2. Instead of the title A. B. his account of goods, sometime A. B.'s sale or A. B.'s sale per such a ship, as A. B.'s sale per the Swallow.

Note 3. In the following set of books, in regard no Invoice-book is supposed to be kept, the consigned goods are enumerated in the Waste-book; but in real business, or where an Invoice-book is kept, the common practice is, to copy them directly into it; and in the Waste-book, to mention only the money paid for freight, or other charges, without taking any notice of the names or quantity of the goods. Thus, the entry in the Waste-book, Aug. 10. narrated in this manner, would stand as follows.

Paid freight, custom, wharfage, portage, &c. of sundry goods per the Griffin, John Temple matter, consigned from Herman Van Beek of Amsterdam, for sale and returns, 141. 12. 6d.

Prob. 2. N. Debtor and Creditor applied in disposing of your employer's goods.

Case 1. WHEN you sell all, or any part of your employer's goods, for ready money, enter Cash Dr to A. B. his account of goods, for the sum received. Aug. 17.

2. When you sell all, or any part of his goods, on time, charge the Buyer Dr to A. B. his account of goods, for the sum due. Aug. 23.

3. When you take all, or any part of his goods, to yourself at the current price; or when you put off his goods in barter, for others which you take to yourself; enter Goods received Dr to A. B. his account of goods, for their value.

4. When all your employer's goods are disposed of, balance his account of goods; that is, charge A. B. his account of goods Dr to Sundries, viz. to Cash, for any charges paid by you, not yet booked; or to the person or persons to whom they are due, if not yet paid; and to Profit and Loss, for your commission; and to A. B. his account on time, for the outstanding debts, if any; and to A. B. his account-current, for the employer's ready money in your hands. Aug. 23.

5. When you receive payment of the outstanding debts, enter as in proper trade, viz. Cash Dr to the Buyers; but if you be obliged to make abatement, for defect in weight or measure, or bad markets, &c. enter Sundries Drs to the Buyer, viz.

Cash, for the sum received,

A. B. his account-current, for the sum abated.

6. When you receive payment of a debt on your employer's account, you must not only give the buyer or payer credit as directed above, but at the same time charge A. B. his account on time Dr to ditto his account-current, for the whole sum of the debt, whether any abatement be allowed or not.

Note 1. If you allow abatement to the buyers, while the account of goods is yet open, you may charge A. B. his account of goods Dr to the Buyers, for the sum abated.

Note 2. When you pay the persons mentioned in case 4. who get credit in balancing the account of goods, such as packers, prelfers, porters, coopers, dyers, brokers, &c. enter as in proper trade, viz. Receiver Dr to Cash; but if they allow abatement, this being your employer's profit, not your own, charge the Receiver Dr to Sundries, viz. to Cash, for the sum paid, and to A. B. his account-current, for the sum abated. Aug. 31.

Prob. 3. O. P. Debtor and Creditor applied when you make returns to your employer.

Returns are made either in goods or bills.

O. § 1. The cases of returns in goods.

Case 1. WHEN you buy up goods for ready money, and ship them off for your employer, enter

A. B. his account-current Dr to Sundries, viz.

To Cash, for prime cost, and charges paid,

To Profit and Loss, for your commission.

2. When you buy goods on time, and ship them off for your employer, enter

A. B. his account-current Dr to Sundries, viz.

To Sellers, for prime cost of the goods,

To Cash, for charges, as custom, insurance, &c.

To Profit and Loss, for your commission.

3. When you take goods of your own, and valuing them at the current price, ship them off for your employer, enter

A. B. his account-current Dr to Sundries, viz.

To Goods sent off for their value,

To Cash, for charges at shipping,

To Profit and Loss, for your commission.

Note 1. There may be several other cases; as, 1. When the goods shipped off are bought, part for ready money, and part on time, May 18. 2. When part of them are bought for ready money, part of them your own, Aug. 30. 3. When part of them are bought on time, the rest being your own. 4. When part of them are bought for ready money, part on time, part of them your own. All which being compounds of the cases mentioned, can prove no difficulty to the learner.

Note 2. The Journal Entry is the same, whether the goods shipped off be in return for goods sold by you, or in answer to your employer's commission, when you have none of its effects or money in your hand, May 18. The entry is also the same, whether the goods shipped off be consigned to himself, or by his order to his factor, or any other person.

Note 3. If the charges on shipping are not pretently paid, the Cr will not be Cash, but the person to whom they are due. May 18. Aug. 30. Or, if you please, the general account, Debts payable, or Charges payable. And when you pay, enter the Receiver, or Charges payable, Dr to Cash, May 22. But if abatement be allowed you, this being your employer's advantage, not your own, enter the Receiver, or Charges payable, Dr to Sundries, viz. to Cash, for the sum paid, and to A. B. his account-current, for the sum abated. Aug. 31.

Note 4. In like manner, when you pay for the goods mentioned case 2. enter as in proper trade, viz. the Sellers Drs to Cash; but if abatement be allowed you, you must charge the Sellers Drs to Sundries, viz. to Cash, for the sum paid, and to A. B. his account-current, for the sum abated.

P. § 2. The cases of returns in bills.

Case 1. WHEN your employer draws a bill on you, which you accept and pay on sight, enter A. B. his account-current Dr to Cash, for value of the bill.

2. When your employer draws a bill on you, payable at 1 or 2 usance, enter A. B. his account-current Dr to Bills payable, for value of the bill. Sept. 3.

3. When you draw upon your employer, enter Cash, if you receive present money for the bill; or, if not, the Remitter Dr to A. B. his account-current, for value of the bill. May 31.

4. When you remit a bill to your employer, for which you pay ready money, enter A. B. his account-current Dr to Cash, for value of the bill. Sept. 8.

5. When you remit a bill to your employer, which you either procure on time, or receive in payment of a debt due to you by the drawer, enter A. B. his account-current Dr to the Drawer, for value of the bill.

6. When

6. When your employer remits a bill to you, enter *Cash*, if you receive present payment; or, if not, *Bills receivable*, Dr to *A. B. his account current*, for value of the bill.

*Note 1.* When you pay the bill mentioned in *case 2.* enter *Bills payable* Dr to *Cash*. *Sept. 10.*

*Note 2.* Charge *A. B. his account current* Dr to *Cash*, for all charges you pay in making returns, such as postage.

*Note 3.* Having now shewn how to keep *factory-accounts* in your own books, along with your other business, it will not be improper to observe, that these accounts may also be kept, by help of the *Sales book*, without bringing any thing to your *Ledger*, or other books, except the *account current*, thus: Turn the *Sales-book* into a folio-form; and when you receive the consigned goods, enter them on the Dr side, mentioning their quantity, mark, and number, with the charges you pay; to which side also carry all after charges, abatements made to buyers, and your own commission. On the Cr side, enter the *sales*, mentioning the names of the buyers on time; and, as they pay, mark the article as paid on the margin; or, which will do just as well, never draw out the sums to the money-columns, till you receive payment. In your *Ledger*, give *A. B. his account current* credit for all the money you receive for his goods, and make the same account Dr for all the charges paid by you, abatements made to buyers, your own commission, and returns made to your employer. But though this method may now and then be used with respect to small consignments; yet the conducting of large concerns in factory requires the use of all the five books mentioned at the beginning of this chapter.

*Note 4.* When you cannot dispose of your employer's goods to advantage, and thereupon by his order ship them off to a factor of your own, in expectation of a better market, the regular method in this case is, 1. When you ship off the goods, enter *Voyage to*—for account of your *Employer*, Dr to *Cash*, for charges paid at shipping 2. When you have advice from your factor, that he has received them, enter your *Employer his account of goods* in the hands of *factor*, or rather your *Employer his account of goods* at such a place, Dr to *Voyage* thither, for charges of the said voyage. 3. When you have advice that he has sold them, *e. g.* for ready money, enter your *Employer his account current at*—Dr to *ditto his account of goods at*—, for neat proceeds. The entry in any other case will be obvious to one who understands *proper trade* and *factorage*, as explained above. But though this be the regular method, yet in real practice, the best way, in our opinion, is, when you ship the goods, to charge the employer's *account of goods* (as they stand in your *Ledger*) Dr to *Cash*, for charges at shipping, making no more entries, till you receive the *Account of sales*, and then charge *A. B. his account of goods*, for the neat proceeds; and discharge *A. B. his account current at* —, as returns are made to you by your factor.

### 3. IN PARTNERSHIP.

PARTNERSHIP is that branch of trade which is ma-

naged and carried on by a trustee, in the name, and for the account of the partners; that is, when a joint stock, made up by two or more merchants, is deposited in the hands of one person, to be employed by him in a way of commerce, according to instructions.

Merchants, upon entering into *partnership*, generally chuse one of their own number, to whom they commit the management of their company-concerns; who, on account of his being partner, as well as manager or doer for the company, is called *partner-trustee*; and shares of gains and losses that happen, according to his share of the stock; and must allow his proportion of all charges, even of his own commission, since, in quality of trustee, he serves himself as partner equally with the rest.

The accounts of the company's affairs may be kept by the trustee in his own books, along with the accounts of his own private business; or they may be kept in separate books allotted for that purpose. The former is common practice, in matters of small concern, or short adventures; the latter is used by fixed companies, whose trade is considerable, or who have the prospect of dealing long that way.

Hence it is obvious, that each partner will have occasion to keep an account in his own books, of every thing he gives in and receives from the company, and also of what he owes to the company, or they to him: and, on the other hand, it will be the business of the trustee, not only to keep clear accounts with the persons he deals with, in buying up and disposing of goods for the company; but he must also keep distinct accounts, with respect to the partners, shewing what share each of them gives in, and what part of neat proceeds is due to them, and likewise what every one of them owes to the company, or the company to them. These things premised,

1. We shall shew how a partner keeps the accounts which he has occasion for.

2. The way how a trustee keeps the accounts of the company's affairs in his own books.

3. The manner of keeping company-accounts in books, apart, that contain nothing else.

1. *How a partner keeps the accounts he has occasion for.*

The *Ledger-accounts* described.

A merchant concerned as partner in a company, must keep the two *Ledger-accounts* following; in which observe, that *A. B.* represents the trustee's name.

1. *A. B. my account in company.* This account is Dr for your inputs, and proportion of all charges, and Cr for your share of neat proceeds.

2. *A. B. my account proper.* This is a personal account, being charged and discharged exactly as such, for the mutual debts and payments betwixt you and the trustee.

*Note 1.* *A. B. my account in company*, is a general title, that may represent one or more kinds of goods; and that whether in the trustee's custody, or by him sent to sea. But different authors title this account differently. Some chuse to express it thus: *Goods in the hands of A. B.*; or particularly, *Broad cloth in the hands of A. B.* If it be a sea-adventure, you may use the title, *A. B. my account of Voyage to* ——. If the company

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be-fixed, the title may be taken from the commodity they deal in, as *Accompt in Wine-company, accompt in Tobacco-company, &c.*; or from the place they trade to, as *Accompt in East-India company, &c.*

*Note 2.* Instead of *A. B. my accompt proper*, some write *A. B. my accompt-current*; some too write *A. B. his accompt current*; and others title this accompt simply by the trustee's name. But though the titles of accompts are in some sort arbitrary, or as the merchant pleases; yet it is suitable or congruous, that they carry in them some badge of distinction, shewing to what class of accompts they belong.

We now proceed to a particular application of Dr and Cr in the cases that most commonly occur on this head, which shall be confined to the two problems following.

**Prob. 1. Q. Debtor and Creditor applied, when you give in your share of stock to the trustee.**

*Case 1.* If you give in just your own part; and that either, 1. In money, or in goods presently bought for ready money; or, 2. In goods presently bought on time; or, 3. In goods already entered in your books, enter *A. B. my accompt in company Dr*

To *Cash*, if you give in money, or pay for goods, *Off. 4.*

To *Seller*, if you buy goods on time,

To *Goods proper*, if the goods were formerly your own.

2. If you find both your own part and the trustee's, enter *Sundries (viz. A. B. my accompt in company, for your own part, and A. B. my accompt proper, for his part) Drs.*

To *Cash*, if you give in money, or pay for goods,

To *Seller*, if you buy the goods on time,

To *Goods proper*, if you give in goods formerly your own, *Off. 9.*

3. If the trustee provide both your part and his own, enter *A. B. my accompt in company Dr to ditto my accompt proper.* And when you pay him, charge *A. B. my accompt proper Dr to Cash.* But if he demand interest, make *Sundries (viz. A. B. my accompt proper, for the debt, and Profit and Loss, for the interest) Drs to Cash.*

*Note 1.* There may be several other varieties in *case 1.* besides those mentioned; as, 1. When you give in part money, part goods presently bought on time. 2. When you give part in money, part goods of your own. 3. When you give in goods, part bought on time, part your own. 4. When you give in part money, part goods bought on time, part goods of your own. In all which cases, enter *A. B. my accompt in company Dr to Sundries*, as follows.

Variety 1	}	To <i>Cash</i> , for the sum given in,
		To <i>Seller</i> , for value of the goods bought.
2	}	To <i>Cash</i> , for the sum given in,
		To <i>Goods proper</i> , for their value.
3	}	To <i>Seller</i> , for value of the goods bought,
		To <i>Goods proper</i> , for their value.
4	}	To <i>Cash</i> , for the sum given in,
		To <i>Seller</i> , for value of the goods bought,
		To <i>Goods proper</i> , for their value.

*Note 2.* The like varieties may be supposed in *case 2.* In journalizing of which, the best method is, first to enter *A. B. my accompt in company Dr to Sundries*, as in the former note, for the whole value of the money, and goods given in; and then, in another entry, charge *A. B. my accompt proper Dr to ditto my accompt in company*, for the trustee's part. And when the trustee pays you for his part, enter *Cash Dr to A. B. my accompt proper, Off. 11.* But if he pay you also interest, make *Cash Dr to Sundries, viz. to A. B. my accompt proper*, for the debt, and to *Profit and Loss*, for the interest.

**Prob 2. R Debtor and Creditor applied, when goods in company are disposed of, and you receive all or part of your share of neat proceeds.**

*Case 1.* If you have advice of sales, and at the same

time receive your share of neat proceeds; which may be either in money, bills, or goods; enter *Cash, Bills receivable, or Goods received, Dr to A. B. my accompt in company*, for value received, *Off. 9.* and 20.

2. If you have only advice of sales on time, without receiving any thing, enter *A. B. my accompt proper Dr to ditto my accompt in company*, for your share of neat proceeds due to you; and when you receive payment, charge *Cash, Bills receivable, or Goods, Dr to A. B. my accompt proper*, for value received. But if the trustee had been obliged to allow abatement to the buyers, or had any of the debts outstanding proved bad, then, in this case, if the *accompt in company* be yet open, enter *Sundries (viz. Cash, Bills receivable, &c. for the sum received, and, A. B. my accompt in company, for your share of the sum abated or lost) Drs to A. B. my accompt proper.* If the *accompt in company* be balanced, charge *Profit and Loss Dr* for your share of the abatement, or of the loss.

3. If the goods are sold, part for ready money, part on time, and thereupon you receive your share of money received, enter *Sundries (viz. Cash, for the sum you receive, and A. B. my accompt proper, for your share of sales on time) Drs to A. B. my accompt in company.*

4. If part of the goods only are sold, you may put off the booking of it till further advice; unless it be for ready money, of which you immediately receive your share: in which case, enter *Cash Dr to A. B. my accompt in company*, for the sum you receive.

5. If you withdraw your share of stock, or any part of it, enter *Cash, or Goods withdrawn, Dr to A. B. my accompt in company*, for the sum or value withdrawn.

6. If after the goods are disposed of, you take up only your share of neat gain, continuing your share of stock as a fund for a new adventure, charge *Cash Dr to Profit and Loss*, for the sum received, and let the *accompt in company* stand as it is.

*N. B.* This is the ordinary case in fixed companies.

*Note 1.* There may be other varieties in *Cases 1. & 2.* besides those mentioned, *viz. 1.* You may receive, as your share of neat proceeds, part money, part bill; and then *Sundries* are *Drs, viz. Cash, and Bills receivable, Off. 9.* 2. You may receive part money, part goods; and then the *Drs* are, *Cash, and Goods received, Off. 20.* 3. You may receive part bill, part goods; and then the *Drs* are, *Bills receivable, and Goods received.* 4. You may receive part money, part bill, part goods; and then there will be three *Drs, viz. Cash, Bills receivable, and Goods received.*

*N. B.* If the person on whom you get the bill have an accompt in your *Ledger*, make him *Dr*, and not *Bills receivable.*

2. How a trustee keeps the company's accompts in his own books.

The Ledger accompts described.

A Trustee who keeps the company's accompts in his own books, has occasion for the three *Ledger-accompts* following, in which *A. B.* represents your partner's name.

1. *Goods in company with A. B. or Sales in company with A. B.* or particularly *Sugar in company with A. B.* This accompt is debited for the value of the goods brought into company, for all charges, and your commission: it is credited as you dispose of the goods, in the same manner as if the goods were your own.

2. *A. B. his accompt in company.* This is credited for your partner's imputs, his share of charges, and proportion of neat gain at close: it is debited for his share of neat

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neat proceeds, and his proportion of loss, if any, when the company accounts are finished.

3. *A. B. his account proper.* This is a personal account, which is debited and credited for the mutual debts contracted and payments made betwixt you and partners.

*Note 1.* If the company deal in foreign trade, you who manage as trustee will have occasion for other accounts, viz. *Voyage in company, Factor our account current, &c.* all which are used the same way as their parallels in *proper foreign trade.*

*Note 2.* As you must keep an *account in company*, and an *account proper*, for each partner; so, if these be compared with the accounts of the like name kept by the partners, they will be found exactly the reverse of one another; that is, the Dr side of the accounts kept by you will be the same with the Cr side of those kept by partners; and on the other hand, the Cr side of the former will be exactly the Dr side of the latter.

*Note 3.* Instead of the title *A. B. his account proper*, a great many use *A. B. his account current.* And it must be owned the merchant is at liberty to do in this as he inclines; it comes to the same thing in the issue, only the one title is more distinctive than the other.

Prob. 1. S. Dr and Cr applied, when goods are brought into company.

*Case 1.* If the goods are bought, (which is either from you the trustee, or from a partner, or from a neutral person,) enter twice; viz. 1st, *Goods in company Dr To Goods proper*, if bought of yourself, } for value of  
*To Partner's account proper*, if of a partner, } the goods  
*To Cash, or Seller*, if of a neutral person, } bought.

2dly, Charge each partner *his account-proper Dr to ditto his account in company*, for his part of the purchase  
*Oct. 26. Nov. 22.*

*Note.* When you pay a neutral person for goods bought on time, charge the said Person Dr to Cash; and there is no second entry. *Oct. 27. Nov. 25.* But if he allow you discount or abatement, enter twice; namely, 1. *Seller Dr to Sundries*, viz. to Cash, for the sum paid, and to *Goods in company*, for the sum discounted or abated. 2. Each partner's *account in company Dr to ditto his account-proper*, for his share of the sum discounted or abated.

*Case 2.* If each partner bring in just his own part of goods to company, enter once; viz.

*Goods in company Dr to Sundries*, viz.  
*To Goods proper*, for value of your share,  
*To each Partner his accounts in company*, for value of their shares.

*Note 1.* This is shorter than to enter as if the goods were bought, though that way would also be right, and prove the same in effect.

*Note 2.* Enter also as above, if the partners give in each his own part in money, with which you buy goods; or, which is the same thing, if upon buying of the goods each partner instantly pay down his part of the price, only Cash, and not *Goods proper*, will be Cr for your own part. *Oct. 22.*

*Note 3.* But if you instantly book the money received from the partners, enter Cash Dr to Sundries, viz. to each partner's *account in company*. And when you buy the goods, charge *Goods in company Dr to Cash*, for their value; and there is no second entry.

*Case 3.* If you or partner pay charges on goods brought into company, as carriage, insurance, &c. this augments the cost, and must be entered as the cost, namely, 1st, *Goods in company Dr*

*To Cash*, if paid by you. *Oct. 25. Nov. 1.*

*To Partner, his account proper*, if paid by him.

2dly, Each partner *his account-proper Dr to ditto his account in company*, for his share of the said charges.

Prob. 2. T. Debtor and Creditor applied, when goods in company are disposed of.

*Case 1.* If goods in company are sold, (which is either to you the trustee, or to a partner, or to a neutral person,) a double entry is necessary; viz. 1st,

*Goods proper*, if sold to yourself,  
*Partner's account-proper*, if to him on time, } Dr  
*Cash, or Buyer*, if to a neutral person,

*To Goods in company*, for their value in the sale.  
 2dly, Each partner *his account in company Dr to ditto his account proper*, for his share of the sale. *Oct. 29.*

*Nov. 1. and 30. Dec. 2. 18. and 28.*

*Note 1.* The entries are the same when you receive freight for a ship in company. *Oct. 25. Dec. 27.*

*Note 2.* When you receive payment for goods in company formerly sold to a neutral person, charge Cash Dr to the Buyer; and there is no second entry. *Nov. 1. Dec. 13.* But if you allow discount or abatement to the buyers, a double entry is necessary; namely, 1st, *Sundries (viz. Cash)*, for the sum received, and *Goods in company*, for the sum discounted or abated) Drs to the Buyer; 2dly, Each partner *his account proper Dr to ditto his account in company*, for his part of the discount or abatement. *Dec. 20.*

*Note 3.* If goods in company be damaged, destroyed, or lost, enter *Sundries (viz. each partner his account proper)*, for their respective shares of the damage or loss, and *Profit and Loss*, for your own share) Drs to *Goods in company*.

*Case 2.* If goods in company are disposed of in barter, for other goods of the same value brought into it, charge *Goods in company received Dr to Goods in company delivered*; and there is no second entry. *Dec. 7.*

*Note 1.* If the goods to be received and delivered be of different values, a double entry will be necessary: As, suppose a trustee engaged in company with *A. B.* each  $\frac{1}{2}$ , should deliver 80 l. worth of broad cloth, in company, for tobacco to the value of 100 l.; in this case he enters twice: 1st, *Tobacco in company Dr to Sundries*, viz. to *Broad cloth in company*, 80 l. and to *Cash, or Dealer*, 20 l.; 2dly, *A. B. his account proper Dr to ditto his account in company*, 10 l. for his share of the money now laid out or due to Dealer. Again, invert the supposition, and admit, that he delivers broad cloth in company to the value of 100 l. and receives 80 l. worth of tobacco, the rest in money, or due by his dealer; in this case he enters also twice: 1st, *Sundries (viz. Tobacco in company)*, 80 l. and *Cash, or Dealer*, (20 l.) Drs to *Broad cloth in company*; 2dly, *A. B. his account in company Dr to ditto his account proper*, 10 l. his part of money received, or due by Dealer.

*Note 2.* If you barter goods in company, for others which you take to yourself, enter also twice: 1st, *Goods proper received Dr to Goods in company-delivered*; 2dly, Each partner's *account in company Dr to ditto his account proper*, for his part of sale. In like manner, if you barter goods of your own, for others which you bring into company, enter twice: viz. 1st, *Goods in company received Dr to Goods proper delivered*; 2dly, Each partner *his account proper Dr to ditto his account in company*, for his part of purchase.

*Case 3.* If you or partner withdraw just your or his exact part of goods in company remaining unfold, enter once, viz.

*Goods proper*, if withdrawn by you, } Dr  
*Partner's account in company*, if by him, }  
*To Goods in company*, for their value in company.

*Dec. 24.*

*Note*

*Note 1.* If you or partner withdraw more or less than your or his exact part, you must account the goods sold, and enter as in *case 1.*  
*Note 2.* When goods in company are all sold, or part sold, and the rest withdrawn, so that all are disposed of, make a double *Journal entry*; viz. 1<sup>st</sup>, *Goods in company* Dr to *Sundries*, viz. to *Cash*, or *Charges of merchandise*, for any charges not yet booked, such as cellar-rent, &c. and to *Profit and Loss* for your own commission, or for interest of money advanced by you. 2<sup>ly</sup>, Each partner *his accmpt-proper* Dr to *ditto his accmpt in company*, for his part of the whole. *Nov. 1.*  
*N. B.* This is also to be done, if it be a voyage in company.

Prob. 3. U. Debtor and Creditor applied in payments betwixt trustee and partners.

*Case 1.* If you the trustee receive payment of partner in money, charge *Cash* Dr to partner *his accmpt-proper*, for the sum received. *Off. 27. Nov. 25.*

2. If partner give you his bill on *E. F.* charge *Cash*, or *Bills receivable*, or *E. F.* Dr to partner *his accmpt proper*, for value of the bill.

3. If you draw on partner, charge *Cash*, or *E. F.* viz. the man you deliver the bill to, Dr to partner *his accmpt proper*, for value of the bill.

4. If you pay partner in money, charge partner *his accmpt-proper* Dr to *Cash*, for the sum paid. *Nov. 4. and 17.*

5. If you give partner your bill on *E. F.* charge partner *his accmpt proper* Dr to *E. F.* for value of the bill.

6. If partner draw on you, charge partner *his accmpt proper* Dr to *Cash*, if you pay at sight; if not, to *Bills payable*.

7. If, in adjusting shares in company, one partner pay into another, charge partner receiver *his accmpt proper* Dr to partner payer *his accmpt proper*, for the sum. *Nov. 27. and 25.*

*N. B.* The entry is the same, if you draw a bill upon one partner payable to another.

8. If partner make payment to *E. F.* of a debt due by the company, charge *E. F.* Dr to partner *his accmpt proper*. *Nov. 25.*

Prob. 4. V. Debtor and Creditor applied, when the company send goods to sea.

*Case 1.* If the goods sent to sea have been formerly brought into company, and stand already entered in the books, upon shipping them off make a double entry; 1<sup>st</sup>, *Voyage in company* to ——— Dr to *Sundries*, viz.

To *Goods in company*, for their value,  
To *Cash*, for charges, as custom, insurance, &c.

2<sup>ly</sup>, Each partner *his accmpt-proper* Dr to *ditto his accmpt in company*, for his share of charges only.

*Note.* If partner pay the charges, the *Voyage* is charged Dr, not to *Cash*, but to partner *his accmpt-proper*.

*Case 2.* If the goods sent to sea are presently bought, (which is either from you, from a partner, or from a neutral person), enter also twice; namely, 1<sup>st</sup>,

*Voyage in company* to ——— Dr to *Sundries*, viz.

To { *Goods proper*, if bought of you,  
*Partner his accmpt-proper*, if of a partner,  
*Cash*, or *Seller*, if of a neutral person;  
And

To { *Cash*, for charges, if paid by you,  
*Partner his accmpt-proper*, if by him.

2<sup>ly</sup>, Each partner *his accmpt-proper* Dr to *ditto his accmpt in company*, for his part of the whole.

*Note 1.* If each partner find just his own part of goods sent to sea, you may enter thus: 1<sup>st</sup>, *Voyage in company* to ——— Dr to *Sundries*, viz. To *Goods proper*, for your share; to each partner *his accmpt in company*, for their respec-

tive shares; and to *Cash*, for charges, if paid by you, or to partner *his accmpt-proper*, if paid by him. 2<sup>ly</sup>, Each partner *his accmpt-proper* Dr to *ditto his accmpt in company*, for his part of charges.

*Note 2.* But if each partner bring in such goods as they have proper for the intended voyage, without regard to their just proportions, being resolved to adjust that matter with money, the best way is, to consider the goods as bought, and enter accordingly; viz. 1<sup>st</sup>.

*Voyage in company* to ——— Dr to *Sundries*, viz.  
To each partner *his accmpt-proper*, for value of the goods brought in by them,  
To *Goods proper*, for value of those given in by you:

And,  
To partner *his accmpt proper*, if by him.  
2<sup>ly</sup> Each partner *his accmpt-proper* Dr to *ditto his accmpt in company*, for their respective shares of the cargo and charges, and not for the value of the goods given in by them. *Nov. 15.*

*Case 3.* If you or partner commission your or his factor, to ship off goods to company's factor; upon receiving the invoice, enter twice; 1<sup>st</sup>,

*Voyage in company* to ——— Dr

To { *Factor my accmpt-current*, if commissioned by you.  
*Partner his accmpt-proper*, if by him.

2<sup>ly</sup>, Each partner *his accmpt-proper* Dr to *ditto his accmpt in company*, for his part of the whole.

Prob. 5. X. Debtor and Creditor applied, upon advice from company's factor.

*Case 1.* If you receive per advice from factor the *accmpt of sales*, enter twice; viz. 1<sup>st</sup>, *Factor our accmpt-current* Dr to *Voyage in company*, for the amount of neat proceeds. 2<sup>ly</sup>, Each partner *his accmpt in company* Dr to *ditto his accmpt-proper*, for his share of the whole.

*Case 2.* If factor in *Jamaica* advise you, that because he could not dispose of the goods to advantage, he has, according to orders, shipped them off to your factor at *Carolina*, enter twice; namely, 1<sup>st</sup>, *Voyage in company to Carolina* Dr to *Sundries*, viz. to *Voyage in company to Jamaica*, for value of the cargo outward, and to *Factor at Jamaica our accmpt-current*, for new charges paid by him. 2<sup>ly</sup>, Each partner *his accmpt-proper*, Dr to *ditto his accmpt in company*, for his share of new charges.

*Case 3.* If the cargo outward be lost at sea, there are three varieties. 1. If none of the goods be insured, enter *Sundries* (viz. each partner *his accmpt in company*, for his part of the loss, and *Profit and Loss*, for your own part) Drs to *Voyage in company*; and no second entry.

2. If the goods be all insured, enter twice; viz. 1<sup>st</sup>, Charge the *Insurers*, or *Cash* if you get present payment, Dr to *Voyage in company*. 2<sup>ly</sup>, Charge each partner *his accmpt in company* Dr to *ditto his accmpt-proper*, for his share of the sum received from, or due by the *Insurers*. 3. If only part of the goods be insured, enter also twice; 1<sup>st</sup>, *Sundries* (viz. *Insurers*, or *Cash*, for the value insured; each partner *his accmpt in company*, for his share of the loss; and *Profit and Loss*, for your own share) Drs to *Voyage in company*. 2<sup>ly</sup>, Each partner *his accmpt in company* Dr to *ditto his accmpt-proper*, for his share of the sum received from, or due by the *insurers*.

Prob. 6. Y. Debtor and Creditor applied, when returns are made by factor.

*Case 1.* If you receive returns in goods, enter twice; namely, 1<sup>st</sup>, *goods in company received* Dr to *Sundries*, viz. to *Factor our accmpt-current*, or to *Voyage in company*.



pany, if not yet discharged, for value of goods; and to *Cash*, for charges here, if paid by you, or to partner *his accmpt-proper*, if by him). 2dly, Each partner *his accmpt-proper* Dr to ditto *his accmpt in company*, for his share of said charges.

Case 2. If you have return in bills, enter once; namely, *Cash*, if remitted to you, and paid at sight, }  
*Bills receivable*, if remitted to you at usance, } Dr  
*Partner his accmpt proper*, if remitted to him, }

To Factor our accmpt current, for value of the bill.

Case 3. If you or partner remit a bill to the factor, enter once, viz. Factor our accmpt current Dr  
To *Cash*, or the *Drawer*, if remitted by you, } for value  
To *Partner his accmpt proper*, if by him, } of the bill.

Prob. 7. Z. Debtor and Creditor applied in admitting a new partner.

THE entries to be made in admitting a new partner not being reducible to distinct cases, we shall explain the matter by a particular example. Suppose then yourself, as trustee, already in company with one partner *A*. each one half, for 300 *l*. and that you agree with *B*. to admit him as a third partner, upon his paying in 100 *l*. as his  $\frac{1}{3}$  share of stock; upon this supposition, the entries to be made are as follows.

1st, You may either let the accmpt of *Goods in company* stand as it is, till the goods are sold, or balance it, by charging *Goods in company with A. and B.* Dr to *Goods in company with A.*

2dly, Charge *A. his accmpt in company* Dr to ditto *his accmpt-proper*, 50 *l*. for his one half of the sale to *B*.

3dly, If *B*. presently pay in his share of stock, there are three varieties. 1st, If he pay the whole to you, charge *Cash* Dr to *B. his accmpt in company*, 100 *l*. 2dly, If he pay the whole to *A*. charge *A. his accmpt proper* Dr to *B. his accmpt in company*, 100 *l*. 3dly, If he pay one half to you, and the other to *A*. charge *Sundries* (viz. *Cash*, 50 *l*. paid in to you; and *A. his accmpt proper*, 50 *l*. paid to him) Drs to *B. his accmpt in company*.

4thly, If *B*. do not pay in his share of stock presently, then charge *B. his accmpt proper* Dr to ditto *his accmpt in company*, 100 *l*.; and when he pays, discharge *his accmpt-proper*, as above.

### III. Of the LEDGER.

THE *Ledger* is the principal book, wherein all the several articles of each particular accmpt, that lie scattered in the other books according to their dates, are collected and placed together, in spaces allotted for them, in such manner, that the opposite parts of every accmpt are set directly fronting one another, on opposite sides of the same folio.

The *Ledger* is the chief or principal book of accmpts, as being that which immediately answers the end of book-keeping. For, as has been already observed, the *Journal* is only preparatory or introductory to the *Ledger*; and the *Waste-book* contains only the matter of accmpts, without either the form or order; whereas the *Ledger* has all the perfection of form and order aimed at in book-keeping, affording a ready answer to all the demands of

the inquisitive merchant; and is therefore justly esteemed the principal book of the three. It is called the *Ledger*, (an Italian word that signifies *art* or *dexterity*), because in it the artificial part of book-keeping chiefly appears. The *Ledger*, in opposition to the scattered order of things in the *Waste-book*, has all the particular articles of each accmpt collected and placed together; and that in such a manner, as to have the opposite articles separated, and set fronting one another on opposite sides of the same folio. Thus, the opposite articles of the *Cash*-accmpt are, the sums of money received, and the sums laid out; which accordingly stand, the former on the Dr side, and the latter on the Cr side of the same folio. Again, in an accmpt of goods, the prime cost and charges go to the Dr side, and the sales to the Cr side; by comparing of which, appears the gain or loss: and so in other accmpts.

The *Ledger* folios are divided into spaces, for containing the accmpts; on the head of which are written the titles of the accmpts, marked *Dr* on the left-hand page, and *Cr* on the right: Below which stand the articles, with the word *To* prefixed to the Dr side, and the word *By* on the Cr side. Upon the margin are recorded: the dates of the articles, in columns allotted for that purpose. The money-columns are the same as in the other books. Before them stands the folio-column, which contains figures directing to the folio where the correspondent *Ledger*-entry of each article is made; for every thing is twice entered in the *Ledger*, viz. on the Dr side of one accmpt, and again upon the Cr side of some other accmpt; so that these figures mutually refer from the one to the other, and are of use in examining the *Ledger*.

For the ready finding any accmpt in the *Ledger*, it has an alphabet, or index, wherein are written the titles of all accmpts, with the number of the folios where they stand.

Note. If the *Ledger*-accmpts be numbered, 1, 2, 3, &c. according to their order; these numbers may be inserted in the Folio-column and Index, and used instead of the folio figures. We have numbered the accmpts of the following *Ledger*, but have not made this use of them; our design being only to refer, by means of them, to the *Ledger*-accmpts as occasion requires.

#### How the Ledger is filled up from the Journal.

To transport immediately from the *Waste-book* to the *Ledger*, would, as has been formerly observed, be a complex task, and require too great a measure of thought and attention; but the former being first reduced to a *Journal*, the transferring from it to the *Ledger* becomes easy, and may be performed by the following

### R U L E S.

1. TURN to the Index, and see whether the debtor of the *Journal* post to be transported be written there: If it be not, insert it under its proper letter, with the number of the folio to which it is to be carried.

2. Upon the folio, and in the head of the space allotted for the accmpt, write the title in a large text-letter

for

for ornament, making it *Dr* on the left side of the folio, and *Cr* on the right.

3. Record the date in the columns on the margin of the *Dr* side, and write the *Cr* with the word *To* prefixed to it, immediately below the title, or other articles formerly posted; and complete the entry in one line, by giving a short hint of the nature and terms of the transaction, carrying the sum to the money-columns; and insert the quantity, if it be an account of goods, &c. in the inner columns, and the referring figure in the folio-column.

4. Turn next to the creditor of the Journal post, and proceed in the same manner with it, both in the Index and Ledger; with this difference only, that the entry is to be made upon the *Cr* side, and the word *By* prefixed to it.

5. The post being thus entered in the Ledger, return to the Journal, and, on the margin, mark the folios of the accounts, writing the folio of the *Dr* above, and the folio of the *Cr* below, a small line drawn between them, thus, 4. These marginal numbers in the Journal are a kind of Index to the Ledger, and are of use in examining the books, and on other occasions.

6. In opening the accounts in the Ledger, follow the order of the Journal; that is, beginning with the first Journal post, allow the first space in the Ledger for the *Dr* of it, the next for the *Cr*, the third for the *Dr* of the following post, if it be not the same with some of those already opened; and so on till the whole Journal be transported.

The above six rules are formed for simple posts, where there is but one *Dr* and one *Cr*; but may easily be applied to complex ones: *e. g.* In posts where only one of the terms is complex, the simple term is entered *Dr* to, or *Cr* by Sundries, or Sundry-accounts, referring to the Journal for particulars. And the single *Drs* or *Cr*s of the complex term, are each of them, in their respective accounts, entered *Dr* to, or *Cr* by the simple term. Again, in posts where both terms are complex, each particular *Dr* and *Cr* are entered *Dr* to, or *Cr* by, Sundry accounts, with a reference to the journal, as before. And here observe, that an article of Sundry-accounts has no referring figure in the folio-column, because it refers to several accounts: But this defect is supplied by the marginal numbers of the Journal, which must still be consulted before the particulars of the indefinite article can be known.

*How to transpose an account from one folio to another.*

WHEN the space allotted for an account proves too little: that is, when either the *Dr* or *Cr* side, or both, are so charged and filled with articles, that they can hold no more; the account must be transposed to a new space: Which may be done by one or other of the methods following.

1. In all accounts that have inner columns for the quantities, such as Account of goods, &c. add up both

the *Dr* and *Cr* sides, and charge the new account *Dr* to the old, for the total of the *Dr* side; and make the old account *Dr* to the new, for the total of the *Cr* side. Thus the old account will be evened; that is, the sums and quantities on both sides will be equal; and the new account will exhibit the same sums and quantities on its *Dr* and *Cr* sides, that the old did, before it was transposed.

2. In accounts that have no inner columns, such as Personal accounts, Cash account, Profit and Loss, &c. where the difference betwixt the two sides is only considered, it is sufficient, after adding up both sides, as before, to carry the balance or difference only to the new account, by making it *Dr* to the old, for the said balance, if the *Dr* side of the old be heaviest; but if the *Cr* side be heaviest, then charge the old account *Dr* to the new. See N<sup>o</sup> 1. and 61.

*Note.* The number of the folio on which the new account is opened, must be inserted in the Index, and also in the folio-column of the old account; and again, the folio-number of the old must be written in the folio-column of the new; that the accountant may readily turn from the one to the other, as occasion requires.

*How the Books are examined.*

AN accountant should be at all imaginable pains in filling up the books, to make them exact and correct: But as errors must happen, the examination of the books after they are written up becomes absolutely necessary.

1. The Waste-book being the first and fundamental book, the only means left for discovering errors in it, are, a careful reading of it, and comparing it with the accountant's memory, or the Book of letters, or Letters of correspondents, Bills, Invoices, &c.; or perhaps some accident or circumstance may happen to bring things to remembrance. And this, with adding up the sums of money anew, is all that can be done.

2. In revising the Journal, compare each post with the Waste-book, to see if the sums of money be right, and whether the narrative or reason of the entry be justly expressed. Next, Consider whether the true *Dr* and *Cr* are assigned; and, after having thus narrowly examined the posts, and corrected what happens to be wrong, return to the Waste-book, and, on the margin opposite to the revised post, make a dash with the pen, thus, /, to signify that the Journal has been compared with it, and found right.

3. The Ledger is revised or examined, by comparing it with the Journal, in the manner following. Take the Journal, and, beginning with the first post, turn (as the marginal numbers direct) to the folio of the Ledger where the *Dr* of the said post stands, and see whether it be duly entered: And, upon finding it right, return to the Journal, and affix to the marginal number of the said *Dr* a dot or point, thus [ . ], to shew that it has been examined. Next, Turn to the folio where the *Cr* is posted, and, upon finding it right, or after correcting it if wrong, return to the Journal, and affix a dot to its referring figure

figure in the margin, for the same purpose as before. If there be more Drs or Crs in the post, proceed the same way with each of them. And thus go on with the next post, and after it with the third, &c. till the whole Journal and Ledger be compared.

As every thing is twice entered in the Ledger, once upon the Dr side of one account, and again upon the Cr side of some other account; it is plain, that the total sum of all the money on the Dr sides will be precisely equal to the total sum of all upon the Cr sides: And therefore the accomptant, after revising the books, is next, for further satisfaction, to add up the Dr sides of the whole Ledger into one sum, and the Cr sides into another. If they agree, it is highly probable that all is right; if they differ, something is unquestionably wrong.

This addition of the Dr and Cr sides is, by merchants, called the *Trial-balance*; and ought to be made, not simply by taking the sum of every page, but by summing the Dr and Cr sides of every account separately, and then adding these on every page into one sum. By going to work in this manner, you lose no labour; for when you come afterwards to close the accounts, instead of adding their Dr and Cr sides anew, you take their sums from the trial-balance.

If, after the revise is made, the totals of the Dr and Cr sides agree, the accomptant may, without further trial, conclude the books to be right. But if they differ, his next step is to examine the Ledger by itself. Which is done thus: Beginning with the first account, compare the first article on the Dr side with its counter-part (to which the referring figure directs), and, upon finding them right, or making them so, affix a dot to the end of the sum, or in the folio or month column of each of them, thus [...], to signify that they have been compared. Proceed in like manner with all the other articles on the Dr side, and next with those upon the Cr side; and then go on to a new account, and from it to the following, till the whole Ledger be finished. Here observe, that, in prosecuting the examination, all the dotted articles you come to are to be omitted, as having been compared already. The Ledger, being thus examined, if the corrections of the errors found bring the sums of the Dr and Cr sides to a balance, the books may now be presumed right; but if not, something is still wrong: And there is no way left to discover the mistake, but a more careful research of the books.

This revising or examination is what merchants call *Pricking of the books*; and should not be put off till the Ledger is filled up, but performed weekly, and in due order; that is, the Waste-book should be revised, before it be posted to the Journal; and the Journal ought to be examined, before it be transported to the Ledger; and the revising of the Ledger finished, before the balance is begun.

#### *How Errors are corrected.*

In explaining the method of correcting errors, we shall join the Waste-book and Journal together, because the manner of correcting is the same in both; and then shew the way of correcting mistakes in the Ledger.

I. Errors in the Waste-book and Journal may be reduced to six classes, and corrected as follows.

1<sup>st</sup>, If the errors be the omission of a whole post, the way to correct or supply the defect is, to write it in a separate place by itself, with a reference to it from the place where it should have been. 2<sup>dly</sup>, If only a word or two be wanting, they may be interlined or written upon the margin. 3<sup>dly</sup>, If a whole post be repeated, or twice written, it is corrected by cancelling one of them; but the cancelling ought to be done in such a slight manner, that the original writing may still be legible and distinct. 4<sup>thly</sup>, In like manner, if only a word or sentence be repeated, let one of them be slightly cancelled. 5<sup>thly</sup>, If there be any wrong name, word, or figure, the best way is, to let the wrong name, word, or figure, stand as they are, but correct the mistake by a note on the margin or foot of the page. 6<sup>thly</sup>, If you commit a mistake, and presently discover it in the very time of writing, the handsomest way of correcting it is, not to alter or cancel any thing, but to write the post or sentence anew, beginning with such a phrase as this, *I say*; as in the following example: *Sold A. B. I say, Bought of A. B.*

II. Errors in the Ledger are of four sorts. 1<sup>st</sup>, When an article is entered upon a wrong account: This is to be corrected, first, by making the other side of the said account Dr to, or Cr by Error, for the sum of the said article; which rectifies this account: After which, the article must be entered in due form, in the account to which it belongs; or rather make the correction thus, *viz.* charge the one account Dr to the other, for so much *per error*. By either of these methods, the error is removed, and the purity of the books restored. 2<sup>dly</sup>, When an article is entered in the right account, but upon the wrong side; that is, upon the Dr side, when it should have been upon the Cr side, or *vice versa*; to correct this, the first thing to be done is, to remove the error, by making the other side of the said account Dr to, or Cr by Error, for the sum of the article: After which, the article must be entered anew upon the right side, as if no such blunder had happened. 3<sup>dly</sup>, When there is an error in a sum of money: This, if it be too little, is corrected by a new charge on the same side, for the defect; and if it be too much, the mistake is rectified by a discharge on the opposite side for the excess, *viz.* the account is debited or credited to, or by *ditto person*, or *ditto goods*, for so much short-posted, or overcharged. 4<sup>thly</sup>, When an article is quite forgot, or neglected, errors of this nature are easily adjusted, *viz.* by making the entry omitted; only observe, that it is not to be crowded in betwixt two former entries, in order to make it possess the place it would have done, had it come regularly in; for though the order, whatever it be, can occasion no error in the issue, yet this interlining would look more confused and irregular than the disorder of the date, which any person skilled in book-keeping will easily perceive to have happened through mistake.

*Of balancing the Ledger, and raising from it an Inventory, to begin a new Set of Books.*

MERCHANTS commonly once a-year balance or close their Ledger, and raise from it the materials of an Inventory to a new set of books, for the ensuing year.

Now,

Now, to make the method of doing this plain and intelligible to a learner, it must be observed, that, by the word *Balance*, merchants understand the difference betwixt the sums on the Dr and Cr sides of any account. Which difference being entered on the defective side, the account is said to be balanced; that is, to have the sums of the Dr and Cr sides evened, or made equal. And the sides of the several accounts throughout the Ledger being thus evened, and the total sums formally set down on the foot of the accounts, the Ledger is said to be balanced, closed, or finished. Again, in order to understand how the new Inventory is formed from the old Ledger, it must be observed, that these balances or differences of the sides of accounts, are of different kinds. In some accounts, the balance is, the gain or loss made upon the sale of goods; in some, the balance is, the price of goods remaining unfold; and in others, it is a debt due to, or by the merchant, &c. Now, balances of the first kind, viz. of gain or loss, must be distinguished from the rest, and carried to the Profit and Loss account; which being done, the balance or difference of its sides, will be the gain or loss made upon one year's trade, and goes to the Stock-account. All the other kinds of balances must be brought together into one space or folio, under the title of *Balance-account*, and are the very articles of which the Inventory is made up. The most natural method of balancing the Ledger is, first to point out what is contained upon the Dr and Cr sides of each account, and consequently what the balances are; and then, to shew the mercantile and approved way of going to work, in closing the Ledger, collecting the balances, and converting them into a new Inventory. This we shall do in the form of problems.

### P R O B. I.

*What the Balances in the Accounts of proper Trade are.*

#### § 1. *What the Balances in proper domestic Trade are.*

##### 1. *Cash-account*, N<sup>o</sup> 1. and 61.

CONTAINS, upon the Dr side, the ready money which the merchant had at first, or when the books were begun; together with all he has received since that time. The Cr side contains all the payments he has made, or the money he has given out. So that the difference of the two sides is, the ready money he has by him; and therefore this account is closed, by being credited by Balance, for the said difference.

##### 2. *An Account of Goods*, N<sup>o</sup> 2. 3. 11. 12. 14. 18. 20. 21. 27. &c.

Contains upon the Dr side, the prime cost and charges; and, upon the Cr side, the sale or disposal of them. So that there are here three varieties. 1. When the goods are all disposed of, which is known by the inner columns being equal, the difference of its sides is, the gain or loss made upon the sale; and so is closed, by charging it Dr to Profit and Loss, for the gain, if the Cr side be heaviest; or giving it credit by Profit and

Loss, for the loss, if the Dr side be heaviest. N<sup>o</sup> 2. 11. 14. 18. &c. 2. When none of the goods are disposed of, which will appear by the Cr side being empty, then it is closed by Balance, for the whole sum on the Dr side. N<sup>o</sup> 21. 27. &c. 3. When only part of the goods are disposed of, which will appear by the inequality of the quantity-columns; this case requires commonly two closing entries, viz. First, the account must be credited by Balance, for the goods remaining, valued at the prime cost; which equals the inner columns: After this, if the money-columns be unequal, it must be made Dr to, or Cr by Profit and Loss, for the gain or loss made upon what are sold; which evens the outer columns, and closes the accounts. N<sup>o</sup> 3. 12.

*Note 1.* If the goods are of different kinds or prices, as they should be distinguished, when posted to the Ledger, by different numbers, or separate inner columns; so care must be taken, in balancing the account, to mention the kind of goods remaining unfold, and to value them at their own prices.

*Note 2.* A merchant may, at any time, know what goods he has on hand, by comparing the inner columns of the Accounts of Goods, without being put to the trouble of inspecting his warehouse, and weighing or measuring the goods themselves.

*Note 3.* If there be inlack or outcome of goods, that is, defect or excess in weight or measure, it will happen, when the goods are all disposed of, that the inner columns will not be equal. In this case, the balance or equality must be restored, by inserting as much in the deficient column as will make it equal to the other, writing the words *Inlack*, *Broke*, *Lost in weight*, *Ullaged*, *Outcome*, or the like, before it, as the reason why it is added: but nothing goes to the money-columns.

##### 3. *Plate and Jewels.*

This account contains, on the Dr side, the things of that kind you are possessed of; and, like an account of goods remaining on hand, is closed, by being credited by Balance.

##### 4. *Personal accounts*, N<sup>o</sup> 5. 6. 7. 9. 10. 13. 15. &c.

Contain, upon the Dr side, the debts due by the person to the merchant, with the payments made upon any other score by the merchant to him. The Cr side contains the payments made by the person to the merchant, with the debts due by the merchant to the said person, upon any other dealings. So that there are here two cases. 1<sup>st</sup>, If the Dr side be heaviest, the difference is a debt due by the person to the merchant. N<sup>o</sup> 13. 24. &c. 2<sup>dly</sup>, If the Cr side be heaviest, the difference is a debt due by the merchant to the person. N<sup>o</sup> 15. 57. And in both cases the account is closed, by making it Dr to, or Cr by Balance, for the difference of its sides.

##### 5. *Bills receivable*, N<sup>o</sup> 25.

This is a general personal account, and contains upon the Dr side, bills accepted, and payable to the merchant. The Cr side contains the payments he has received. So that the difference of its sides (if there be any) is, what is yet unpaid: And the account is closed, by giving it credit by Balance, for the said difference.

##### 6. *Bills*

6. *Bills payable*, N° 52.

This is an account of the same nature with the former; and contains, upon the Cr side, the bills accepted by the merchant, payable to others; and, upon the Dr side, the payments he has made. So that the difference of the sides (if there be any) is the bills yet unpaid: And the account is closed, by charging it Dr to Balance.

7. *Bills of Exchange*.

This account exhibits, on the Cr side, all the bills you draw on your factors or correspondents; and the Dr side shows what of them are accepted, protested, or yet outstanding; and is closed, if the sides happen to be unequal, by being debited to Balance, for the bills out-standing, viz. the bills of whose acceptance you have hitherto had no advice.

8. *Bonds*.

This account exhibits, on the Dr side, all the bonds you have received, and on the Cr side, what of them are paid, or out-standing; and is closed, if the sides happen to be unequal, by being credited by Balance, for the bonds yet unpaid.

9. *Suspense-account*, N° 34.

Contains, upon the Dr side, the goods sent off; and upon the Cr side, either the same goods returned, or advice from your correspondent that he designs to keep them, or the price sent up. So that either the sides of this account are equal, and then the account closes of itself; or, if there be any difference, it is owing to your having hitherto had no advice concerning some of the goods sent off; and in this case the account is closed, by being credited by Balance, for the said difference.

10. *Foreign Coin*, N° 26.

Contains, upon the Dr side, the value at which the several pieces are received; and on the Cr side, the value at which they are put off. In closing this account, there are three cases. 1<sup>st</sup>, If the pieces are all disposed of, the account is closed, by being debited or credited to or by Profit and Loss, for the gain or loss made by them. 2<sup>dly</sup>, If none of the pieces are yet disposed of, it is closed by being credited by Balance, for the whole value on the Dr side. 3<sup>dly</sup>, If part of them are disposed of, and part of them yet on hand; in this case, the account must first be credited by Balance, for value of the pieces on hand; and if after this the money-columns still remain unequal, it must be debited or credited to or by Profit and Loss, for the said difference; which is the gain or loss made upon the pieces disposed of.

11. *Wagers Account*.

Contains, upon the Dr side, the consignments made when the wagers were entered into. The Cr side contains the decisions of the wagers. So that here occur two varieties, viz. 1<sup>st</sup>, If all the wagers are determined, the difference of the sides will be the gain made upon those decided in favour of the merchant; and the account is closed, by being charged Dr to Profit and Loss, for the said difference. 2<sup>dly</sup>, If any of the wagers are yet undecided, the account must first be credited by Balance for them: After which, if the sides are still un-

equal, it must be charged Dr to Profit and Loss, for the difference.

12. *Deceased Person's Estate*.

The Dr side of this account exhibits the legacies, bills, or debts, you the executor have paid on account of the person deceased; and the Cr side shows what he died possessed of: And the account is closed, by being made Dr to Profit and Loss, for the difference of its sides; which is the sum that falls to you the executor.

13. *Accounts of Ships, Houses, and other Possessions*, N° 4.

Contain, upon the Dr side, what they cost at first, or are valued at, with all charges, such as repairs, or other expences laid out upon them. The Cr side contains, (if any thing be writ upon it), either what they are sold or exchanged for, or the profits arising from them; such as freight, rent, &c. Here there are three cases. 1<sup>st</sup>, If nothing be written upon the Cr side, it is closed, by being credited by Balance. 2<sup>dly</sup>, If the Cr side be filled up, with the price of the ship, house, &c. sold, or otherwise disposed of, then the difference of the sides is the gain or loss made upon the sale; and the account is closed, by being debited or credited to or by Profit and Loss. 3<sup>dly</sup>, If the Cr side contain only the freight or rent; in this case, first charge the ship, house, &c. Dr to Profit and Loss, for the freight or rent; and then close the account with Balance. N° 4.

14. *House-expences, Charges of Merchandize, Refusal of Bargains, Interest-account, Insurance-account*, and all others of the like nature, that are disbursements for which nothing comes in, or pure incomes for which nothing goes out. N° 65. 42. 35.

Contain, upon their Dr sides, the articles of loss, and upon the Cr sides the articles of gain; and are closed, by being debited or credited to or by Profit and Loss, for the difference of their sides.

15. *Profit and Loss*, N° 38.

Contains, upon the Dr side, the articles of loss, and on the Cr side the articles of gain. To this account are carried, not only whatever comes in course to it from the Journal, but also all the articles of gain and loss that occur in closing the Ledger-accounts. After which, the Dr and Cr sides being added up, their difference is the neat gain or loss made since the books were begun; and therefore this account is closed, by being debited or credited to or by Stock, for the difference of its sides.

16. *Stock-account*, N° 8.

As gathered from the Journal, contains, upon the Dr side, the debts due by the merchant when the books were begun. The Cr side contains his ready money, effects, and debts due to him at the same time. But then, to this account, as it now stands, there is brought, at closing of the Ledger, the difference of the sides of the Profit and Loss account. After which, the Dr and Cr sides being added up, and compared, their difference will be the merchant's present neat stock; and the account is closed by Balance.

§ 2. *What the Balances in proper Foreign Trade are.*

1. *Voyage to, or from ———, N° 16. 40. 47.*

Contains, upon the Dr side, the prime cost and charges of the cargo. The Cr side is either empty, or it contains the receipt or disposal of the goods by the factor, or perhaps returns made for them. There are therefore here two cases. 1<sup>st</sup>, If the Cr side be empty, the ship is still at sea, or, at least, there has been as yet no advice of her arrival; and the account is closed, by giving it credit by Balance. 2<sup>dly</sup>, If the Cr side be filled up, the difference of the sides is the gain or loss made upon the voyage; and accordingly the account is closed by being made Dr or Cr to or by Profit and Loss. If the sums of the sides happen to be equal, there is neither gain nor loss on the voyage; and the account closes of itself.

2. *A. B. my Account of Goods.*

Contains, upon the Dr side, the goods consigned to, and received by the factor; and on the Cr side, the disposal of the said goods. This account balances exactly as an *Account of goods in proper domestic trade.*

3. *A. B. my Account on Time.*

Contains, upon the Dr side, the debts due to the factor, for my goods sold by him on time. The Cr side contains the payments made by debtors to the factors. So that, if there be any difference of the sides, it is the debts yet out-standing: And the account is closed, by giving it credit by Balance.

4. *A. B. my account-current, N° 41. 53.*

Contains, upon the Dr side, the money in the factor's hands, received by him of the sales of my goods, with the remittances I had sent him, or payments I have made him upon any other account. The Cr side contains the payments or remittances he has sent me, with the debts I owe him upon any other score. In closing this account, there are two cases. 1<sup>st</sup>, If the inner columns, which contain the foreign money, be equal; then, if there be any difference between the outer columns, it is the gain or loss made by exchange; which flows from the different rates of exchange at which these debts have been charged and discharged: And the account in this case is closed, by being made Dr to or Cr by Profit and Loss, for the difference of the outer columns. 2<sup>dly</sup>, If the inner columns are unequal, they must first be brought to an equality, by making the account Dr to, or Cr by Balance, for their difference, valuing the foreign money at the current rate of exchange; which difference is a debt due by the factor if the Dr side be heaviest, but due to the factor if the Cr side be heaviest. If after this the outer columns are unequal, their difference is, the gain or loss made by exchange; and the account must be closed, by making it Dr to or Cr by Profit and Loss, for the said difference.

P R O B. II.

*What the Balances in Factory-accounts are.*

1. *A. B. his Account of Goods, N° 48.*

This account contains, upon the Dr side, the charges paid by the factor. The Cr side contains the sale or disposal of the goods. In closing this account, there are five varieties. 1<sup>st</sup>, If the goods are all sold, and all the money received, this account is balanced, by being charged Dr, first to Profit and Loss, for the factor's commission, at so much *per cent.* after which, the difference of the sides is, the money due to the employer; and is closed, by being again charged Dr to *A. B. his Account-current*, for the said difference. 2<sup>dly</sup>, If the goods are all sold, but no money yet received, it is closed, by being made Dr to Profit and Loss, for the factor's commission, and to *A. B. his Account on Time*, for the out-standing debts due to him. 3<sup>dly</sup>, If the goods are all sold, and only part of the money received, it is closed, by being made Dr to Profit and Loss, for the factor's commission; to *A. B. his Account on Time*, for the out-standing debts; and to *A. B. his Account-current*, for the employer's money in factor's hands. 4<sup>thly</sup>, If none of the goods be yet sold, it is closed, by giving it credit by Balance, for the sum of the charges on the Dr side. 5<sup>thly</sup>, If only part of the goods are sold, and so the account unfinished, the best way to close it is, by a double balance; that is, first charge it Dr to Balance, for the sum upon the Cr side; and then give it credit by Balance, for the charges on the Dr side. Thus the account will appear in the new books in the same state that it did in the old.

2. *A. B. his Account on Time, N° 49.*

Contains, upon the Cr side, the debts due by those who bought the employer's goods; and as these debts are paid in to the factor, it is charged Dr to *A. B. his Account-current*, for the said payments; and therefore, if, at closing of the Ledger, there be any difference of its sides, it is the debts yet out-standing; and is closed, by being charged Dr to Balance, for the said difference.

3. *A. B. his Account-current, N° 36. 50.*

Contains, upon the Dr side, the money laid out by the factor for the employer's use, as in answering his bills, or remitting bills to him, or otherwise. The Cr side contains the money in the factor's hands belonging to the employer. So that the difference of its sides is, the debts due by the factor to *A. B.* or by *A. B.* to him; and the account is closed, by being made Dr or Cr to or by Balance.

*Note*, If the factor dispose of the employer's good on trust, to persons with whom he has private dealings of his own, it will be proper, in closing their accounts, to divide the balance into two parts, *viz.* one due for the employer's goods, and the other due to or by himself.

PROB.

P R O B. III.

*What the Balances in Company-accounts are.*

§ 1. *What the Balances in the Accounts kept by a Partner are.*

1. *A. B. my Account in Company, N° 54.*

CONTAINS, upon the Dr side, the partner's inputs, and share of charges; upon the Cr side, the returns made; and the difference is the gain or loss. In balancing this account, there are two cases. 1<sup>st</sup>, If the account be finished, *i. e.* if the goods be sold, and returns made, it is closed, by being made Dr or Cr to or by Profit and Loss. 2<sup>dly</sup>, If the account be yet unfinished, the best way is, to close it with a double balance; that is, to make it Dr to Balance, for the sum of the Cr side, and give it credit by Balance, for the sum of the Dr side.

2. *A. B. my Account-proper, N° 55.*

This account is merely personal, and closed with Balance, for the difference of its sides; which is the debt due to, or by the company.

§ 2. *What the Balances of the Accounts kept by a Trustee in his own Books are.*

BEFORE the trustee close the company's accounts, he ought to make the double Journal entry following, if it be not done already; namely, 1<sup>st</sup>, Goods in Company, or Voyage, &c. Dr to Sundries, *viz.* to Cash, for all charges not yet stated to account, such as cellar-rent, &c. and to Profit and Loss, for his own commission, at so much *per cent.* 2<sup>dly</sup>, Each partner's Account-proper Dr to his Account in Company, for their respective shares of the above charges and commission. These entries being made, the balances of the accounts are as follows.

1. *Goods in Company, N° 58. 62. 71. 74.*

Contains, upon the Dr side, the prime cost of the goods stocked in, with all charges, and the trustee's commission. The Cr side contains the disposal of them. The difference of the sides is gain or loss, to be divided amongst the partners. Here there are three cases. 1<sup>st</sup>, If the goods be all sold, the account is closed, by being debited or credited to or by Sundries, *viz.* to, or by each partner's Account in company, for their shares of the gain or loss; and to, or by Profit and Loss, for the trustee's own share. 2<sup>dly</sup>, If none of the goods are sold, then the account is closed, by being credited by Sundries; *viz.* by each partner's Account in Company, for their shares of the goods unsold; and by Balance, for the trustee's share. 3<sup>dly</sup>, If part of the goods are sold, and part of them yet remain not disposed of, this case is a compound of the two former; and accordingly the account is closed, by making the entry mentioned in the first case, for the gain or loss on those sold; and then, by making the entry mentioned in the second case, for those not disposed of.

2. *Voyage in Company, N° 66.*

Contains, upon the Dr side, the value and charges of the goods sent to sea. The Cr side contains the receipt or disposal of them by the factor. The difference of the sides is gain or loss. Here there are three cases. 1<sup>st</sup>, If the Dr and Cr sides be equal, then the account closes of itself. 2<sup>dly</sup>, If one of the sides exceed the other, then the account is closed, by being made Dr or Cr to or by Sundries; *viz.* to, or by each partner's Account in Company, for their shares of the gain or loss; and to, or by Profit and Loss, for the trustee's share. 3<sup>dly</sup>, If nothing be yet writ upon the Cr side, then the account is closed, by being credited by Sundries, *viz.* by each partner's Account in Company, for their shares of the goods at sea; and by Balance, for the trustee's share.

3. *Factor our Account of Goods.*

Contains, upon the Dr side, the company's goods consigned to, and received by the factor. The Cr side contains the disposal of them. The difference of the sides is gain or loss made upon the sale of them. This account has the same varieties, and is balanced the same way with *Goods in company.*

4. *Factor our Account-current.*

Contains, upon the Dr side, what money belonging to the company is in the factor's hand. The Cr side contains the returns he has made in goods or bills. The difference is the debt due to or by the factor. This account is closed, by being made Dr or Cr to or by Balance, for the said difference.

5. *Partner his Account in Company, N° 59. 69. 70.*

Contains, upon the Cr side, the partner's inputs, with his share of charges, and of gain at close. The Dr side contains returns for inputs disposed of, or goods remaining unsold, with the partner's share of losses, if any. This account, after the preceding accounts are balanced, will always close of itself; as is evident by considering what goes to the two sides of it: so that if the balance of this account fail, the accountant may conclude, for certain, that something in the company's accounts is wrong, or at least some mistake has happened in closing them.

6. *Partner his Account-proper, N° 60. 67. 68.*

Is a personal account, the difference of whose sides is the debt due to or by the partner, and is closed with *Balance.*

*Note.* If the design of balancing the company-accounts be, not in order to know the state of the company's affairs, but only that the old Ledger may be finished, and the accounts carried to new books; the accountant, in this case, may either balance them as above directed; or he may, if he pleases, close all of them by a double balance; which is the easiest and shortest way, and will have the same effect in the issue.

§ 3. *What the Balances of the Accounts kept by a Trustee in separate Books are.*

1. *Goods in Company, and Voyage in Company,*  
HAVE the same things upon their Dr and Cr sides, as when

when kept in books along with other business; but are closed with *Profit and Loss in Company*, for the gain or loss; and with partners *Accompts in company*, for their respective shares of goods remaining unfold, or at sea.

#### 2. *Cash in Company*,

Contains, upon the Dr side, the sums of money given in by partners, and received from dealers for goods sold; the Cr side contains the sums laid out; so that the difference of its sides is the money on hand; and is closed with *Balance in company*.

#### 3. *Partner his Account in Company*,

Contains the same thing upon its Dr and Cr sides respectively, as when kept in books along with other business; and, after the accounts of goods and voyages are balanced, will always close of itself.

#### 4. *Partner his Account proper*.

This and all personal accounts, as they contain the same things upon their Dr and Cr sides, as their parallels, in proper trade, so they are all closed with *Balance in company*.

#### 5. *Profit and Loss in Company*.

The difference of its sides is the gain or loss made upon company-trade, and must be charged Dr to the trustee his Account proper, for his commission; after which, it is closed, (if no Stock-account is kept), by being made Dr or Cr to or by Sundries, *viz.* Each partner *his account in company*, for the respective shares of gain or loss. But if you keep a *Stock-account in company*, then this account is closed with it; and the Stock-account is again closed with the partners *Accounts in company*.

#### 6. *Balance in Company*,

Contains, upon the Dr side, the company's ready money in the trustee's hand, with the debts to the company, whether by partners or dealers; the Cr side contains the debts due by the company, and that whether to partners or to dealers: And if the books have been rightly kept, and duly balanced, the two sides of this account will always equal one another to a farthing.

*Note.* If you incline the goods remaining unfold, or at sea, should appear upon the Balance-account, you must close the Account of goods and Voyages with *Balance in company*, for the value of the quantity not disposed of, or at sea; and you may close the partners Accounts in company (which in this case will not close of themselves), either with their *Accounts proper*, or with *Balance in company*, as you please.

#### *How the Balances are collected, the Ledger closed, and a new Inventory formed.*

WHEN you design to balance your Ledger, in order to begin a new set of books, proceed in the manner following.

Take two sheets or folios of loose paper, rule them like the Ledger, and write on the heads or tops of them, the titles of the two following Accounts, *viz.* on the head of the one, *Profit and Loss Dr*, and *Contra Cr*;

on the other, *Balance Dr*, and *Contra Cr*. Then, beginning with the Account of cash, go over every account in the Ledger, (omitting only the Accounts of Profit and Loss and Stock, which must be left open to the last), and carry the articles of gain or loss found on any of them, to the Profit and Loss sheet; and the articles of debt, or goods remaining, to the Balance sheet, without touching the accounts themselves: *e.g.* Taking from the Trial-balance the sums of the Dr and Cr sides of the Cash-account, subtract the one sum from the other, and, on the Balance sheet, make Balance Dr to Cash, for their difference, being the ready money in your hands. Again, in an Account of goods that are all sold, taking the sums of the Dr and Cr sides, subtract the one from the other, and, on the other sheet, make Profit and Loss Dr or Cr to or by the said Account of Goods, for the difference of its sides. And in this manner proceed with every other account in the Ledger, according to their nature, as explained in the last section.

Having advanced thus far, your next step is, to add up the Dr sides of the Profit and Loss sheet, and the Profit and Loss account in the Ledger, into one sum, and their Cr sides into another; and, on the said sheet, make Profit and Loss Dr or Cr to or by Stock, for their difference: Which difference being carried to the Stock-account, add up its Dr and Cr sides, and carry their difference to the Balance sheet. Which being done, the total sums of the Dr and Cr sides of the Balance sheet will be equal to a farthing, if the books be right, and the balancing work truly performed: As may be thus demonstrated.

It is obvious, that the Balance sheet, before the balance of the Stock-account is brought to it, contains, upon the Dr side, the money and goods you have on hand, or at sea, or in the hands of factors, with the debts due to you; the articles on the Cr side are the debts due by you to others: So that the difference of its sides is your present worth, or neat stock. Now, if the balance of the Stock-account be also equal to your present neat stock, it is plain, that it will even the sides of the Balance-account. But that it is so, appears thus.

Your present neat stock is equal to your neat stock when the books were begun, with the addition of the gain, or diminution of the loss, made since that time: but the difference of the sides of Stock-account, before the balance of Profit and Loss account be brought to it, is your neat stock when the books were begun; and the balance of Profit and Loss account, is the gain or loss made since that time; which, consequently, being brought to Stock-account, makes the balance of Stock-account equal to your present neat stock; and therefore the balance of Stock-account evens the sides of Balance-account.

If, after the balance of Stock-account is brought to Balance-account, the sides happen to be still unequal, there has unquestionably some error been committed; which you must find out by a careful review of the balancing work: for here the error must lie, since the books are supposed to have been examined, and found right, or made so, before the balancing was begun. On the other hand, if the sides of Balance-account be equal,

all



all may be presumed right. There is not, indeed, an absolute certainty in the case: for, if you imagine two mistakes committed, either both in the articles of Profit and Loss, or both in the articles of Balance, or one in the former, and the other in the latter, both excesses, or both defects, equal, and on opposite sides, it is plain this would not impede the equality of the Dr and Cr sides of the Balance-account. But then this is so great a chance, that it is more than probable such a thing can never happen, and pass too, without being discovered.

Having brought the two sides of the Balance-account to an equality, which is the test of every thing being right, proceed to close the Ledger-accounts, thus. First, to the Profit and Loss account, transfer the articles on the Profit and Loss sheet. Next, at the end of the Ledger, erect an Account of Balance, into which transcribe the Balance sheet. After which, return to the beginning of the Ledger, and giving the Cash-account credit by Balance, for your ready money, draw a line across the money-columns on each side, at the foot of the account; below which set down the total sums, which will be now equal. Proceed in like manner with all the following accounts, transferring to each the respective articles that belong to them, from the two sheets of loose paper, inserting the referring figures in the folio-column, and writing the total sums on the foot of the account; by which means all the accounts in the Ledger will come to be balanced and closed; that is, evened and finished.

But here it will be proper to observe, that merchants,

in balancing their Ledger, do not all go the same way to work. For some, instead of proceeding according to the above directions, close their Ledger-accounts, and post the closing entries to the Accounts of Profit and Loss, and Balance, all at the same time. And it must be owned, that this way, practised with care, will well enough answer the purpose; but to post the closing entries in the first place, and then to close the accounts, seems to be the surer and better method.

The Ledger being now closed, the next thing to be done is, to begin a new set of books; in order to which, a new inventory must be fetched from your old books, as the foundation of your future trade in the new. Now, it is plain, at first view, that the several articles on the Dr side of the Balance-account, being the particular items of your effects, and debts due to you, make up the first part of the Inventory; and the several articles on the Cr side, except the last, being the debts due by you to others, make up the second part of it: and accordingly in your new Journal, the several particulars on the Dr side must all of them be made Drs to *Stock*, and *Stock* Dr to the several particulars on the Cr side; and *Stock*-account in your New Ledger will stand thus:

*Stock Dr,*  
*To Jacob Russel,*  
*To H. V. Beek,*  
*&c.*

*Contra Cr,*  
*By Cash,*  
*By Indian chints,*  
*&c.*

W A S T E - B O O K .

Edinburgh, the 1st of January 1769.

An Inventory of the money, goods, and debts belonging to me A. B. as also of the debts due by me to others, viz.

	l.	s.	d.
Have in ready money	12000	00	0
Also 2000 yards fine linen, at 2s. 6d.	250	00	0
15 pieces Indian chints, at 24l. 10s.	367	10	0
1/2 of the ship Britannia (freighted by Mr Steel and comp. for a voyage to Barbadoes) with repairs, cost	348	10	0
John Harris owes me per note, on demand,	45	00	0
Thomas Freeman owes me per bill, due 2d February next,	96	00	0
George Evans owes me per bond, dated the 11th Nov. last, and payable Mart. next, with interest at 5 per cent.	300	00	0
	13407	00	00

I owe as follows.

To Joseph Martin, on demand,	36	00	0
To Sir Isaac Crisp, due 1st of June next,	120	00	0
	156	00	00
A.			
6th.			
Bought for ready money, 40 pieces cambrics, at 2l. 16s.	112	00	00
B. 1. F. 1.			
10th.			
Bought of John Vernon 100 pieces duroys, at 26s. to pay at two months,	130	00	00
B. 3.			
15th.			
Paid Joseph Martin in full,	36	00	00
F. 4.			
Bought of Jacob Ruffel 26 pieces druggets, at 7l. 10s.			
l. s. d.			
Paid half down,	97	10	0
Rest due on demand,	97	10	0
	195	00	00
B. 5.			

W. B. N<sup>o</sup> 1. January 21st. Sent as an adventure to Jamaica, in the ship Hopewell, Captain Gordon matter, consigned to William Boyd, the following goods, marked and numbered as per margin, viz.

	l.	s.	d.
70 pieces of my own duroys, at 26s.	91	00	0
6 pieces holland, presently bought of Jacob Green, at 18l. to pay at 2 months,	108	00	0
Paid charges, till on board,	14	11	4
Paid also premium to Simon Smith and company, for insuring 200 l.	10	00	0

G. 4.

223 11 04

30th. Paid Jacob Ruffel, in full for druggets,

F. 4.

97 10 00

February 2d. Bought of Edward Harley 1000 yards broad cloth, at 13s. 6d.

	l.	s.	d.
Paid him part in money,	330	00	0
Given him a bill on John Harris for	45	00	0
Rest due at 3 months,	300	00	0

B. 7.

675 00 00

5th. Received of Thomas Freeman in full,

E. 4.

96 00 00

16th. Bought for present money the goods following, viz.

	l.	s.	d.
90 pieces kerseys, at 6l.	540	00	0
120 pieces fustians, at 37s. 6d.	225	00	0

B. n. 1.

765 00 00

25th. Sold 10 pieces druggets, at 8l. 3s. for ready money,

C. 1. E. 1.

81 10 00

March 1st. Sold George Young 400 yards broad cloth, at 14s. to pay at 1 month,

C. 3.

280 00 00

4th. Sold John Keil my 90 pieces kerseys, at 6l. 7s.

	l.	s.	d.
Received in part,	300	00	0
Rest due at 20 days,	271	10	0

C. 5.

571 10 00

10th. Paid John Vernon, in full for duroys,

F. 4.

130 00 00

Lent Jacob Spencer, upon bond, for 6 months, at 5 per cent.

F. 2.

1000 00 00

March

( 3 ) W A S T E - B O O K.

W A S T E - B O O K. ( 4 )

	l.	s.	d.
March 17th.			
Sold <i>Jacob Preston</i> 200 yards broad cloth, at 14s. and 2d. for payment whereof he has given me a bill on <i>Henry Sidney</i> , payable at sight; the sum is	141	13	04
C. 2. F. n. 4.			
22d.			
Sold <i>Richard Stone</i> 400 yards broad cloth, at 14s. 3½d. which he has paid, as follows, viz.			
Given me 26 moidores, at 27s. 35 02 0			
Given me in <i>British</i> coin, 150 14 8			
And for the rest, an assignment } on <i>G. Digby</i> , - - - } 100 00 0			
C. 4. F. n. 8.	285	16	03
23d.			
Paid <i>Jacob Green</i> in full for holland, as follows, viz.			
Given him my 26 moidores at 26s. 6d. 34 09			
And the rest in <i>British</i> coin, - 73 11			
F. 4. & n. 8.	108	00	00
Received of <i>Henry Sidney</i> , in full of <i>Jacob Preston's</i> bill,	141	13	04
E. 4. F. n. 4. & 9.			
April 1st.			
Received of <i>John Keil</i> , in full for kerseys, the sum of } 280 00			
Abated him, on account he complains two of the pieces proved not so good as the rest, } 1 10			
E. 6.	271	10	00
6th.			
Received of <i>George Young</i> , in full for broad cloth.	280	00	00
E. 4.			
10th.			
Bartered 2 pieces <i>Indian</i> chints, at 25l. for 40 pieces lockrams, of the same value, viz at 25s.	50	00	00
D. 1.			
16th.			
Bartered 1000 yards linen, at 2s. 8d. for the following goods of the same value, viz.			
1 C. cochineal, valued at 108 16 0			
64 lb. cinnamon, at 7s. 8d. 24 10 8			
D. 3.	133	06	08
22d.			
Bartered 6 pieces <i>Indian</i> chints, at 24l. 15s. for			
8 bales muslin, at 12l. 16s. 102 8			
The balance I have received in money 46 2			
D. n. 2.	148	10	00

	l.	s.	d.
April 30th.			
Bartered with <i>George Dennis</i> 1000 yards linen, at 2s. 9d. 137 10 0			
And 2 pieces <i>Indian</i> chints, at 25l. 50 00 0			
For 17 bags cotton, containing } 42 C. 2 Q. neat, at 3l. 15s. } 159 07 6			
per C. - - - - - } 5 09 0			
And 12 lb. cloves, at 9s. 1d.			
D. 4.	187	10	00
164	16	06	
May 3d.			
Paid <i>Edward Harley</i> , in full for broad cloth	300	00	00
F. 4.			
7th.			
Sent <i>Nathaniel Napier</i> , in the country, 16 pieces druggets, desiring him to take them a 7l. 15s.; if not, to return them on my charges.	124	00	00
C. n. 4.			
13th.			
Paid <i>Simon Smart</i> , as a penalty for refusing a bargain of <i>Norwich</i> luffs,	202	00	
B. n. 2.			
18th.			
J. J. Shipped on board the <i>Swan</i> , <i>Robert Scott</i> N <sup>o</sup> 1. master, by order and for account of <i>John Jessop</i> merchant in <i>Genoa</i> , the following goods, marked and numbered as per margin, viz.			
8 tun lead, bought of <i>George Dennis</i> , at 13l. 10s. to pay at 1 month, } 108 00			
7535 lb. tanned leather, presently bought for ready money, at 7d. } 219 16			
Paid custom and other charges 10 10			
Due to <i>George Aiton</i> for packing, 1 05			
My commission at 2½ per cent. 8 10			
Paid <i>Simon Smith</i> and company, for insuring 350l. on the whole, } 10 10			
My commission on ditto, at ½ per cent. } 1 15			
O. n. 1. 2. 3.	360	15	00
22d.			
Paid <i>George Aiton</i> , in full for packing <i>John Jessop's</i> leather,	105	00	
O. n. 3.			
31st.			
Drawn my bill on <i>John Jessop</i> in <i>Genoa</i> , for 960 dollars, payable to <i>George Stapleton</i> , on order, for value here received, at 50d.	200	00	00
P. 3.			
June 3d.			
Dr <i>George Friend</i> is deceased, and has left me a legacy, payable by his executor <i>Jobn Vernon</i> , the sum is	200	00	00
E. n. 5.			
8th.			
Paid <i>Sir Isaac Crisp</i> in part,	80	00	00
F. 4.			

June

	l.	s.	d.
June 16th.			
<i>Nathaniel Napier</i> writes me, that he designs to keep the 16 pieces of druggets sent him the 7th of May last, and promises payment, viz. the one half against the 1st of August next, and the other half at <i>Martinmas</i> , the whole being	124	00	00
C. n. 4.			
18th.			
Received advice from <i>William Boyd</i> in <i>Jamaica</i> , That he hath received and sold my adventure, the neat proceeds, as per account of sales, amounting to 304 <i>l.</i> 7 <i>s.</i> In return for which, he hath put on board the same ship the following goods, desiring me to draw for the rest, viz.			
6 barrels indigo, containing 126 lb. per barrel, at 2 <i>s.</i> 2 <i>d.</i> per lb.	81	18	00
5 hogheads pimento, containing in all 1535 lb. and 6 <i>d.</i> per lb.	38	07	06
5 hogheads sugar, containing 63 C. at 19 <i>s.</i> per C.	59	17	00
Charges as per his invoice,	15	04	11
Balance in his hands,	108	19	07
H. 5.	304	07	00
22d.			
Settled accounts with <i>George Dennis</i> , and paid him in full,	85	06	06
F. 4.			
June 29th.			
Paid Sir <i>Isaac Crisp</i> in full,	40	00	00
F. 4.			
July 2d.			
Paid shop-rent for half a year, viz. from <i>January 1.</i> to <i>July 1.</i>	12	00	00
F. 12.			
5th			
Paid my shopkeeper his bill of postage, and other petty charges,	2	12	08
F. 12.			
9th.			
Ship <i>Hopewell</i> is arrived safe with my goods from <i>Jamaica</i> ; freight, duty, and other charges paid here, amount to	97	12	00
K. n. 2.			
Sold <i>John Dyer</i> my six barrels indigo upon the key, at 4 <i>s.</i> 3 <i>d.</i> per lb.			
Received in part,	80	13	
Rest due at 6 months,	80	00	
K. n. 2.	160	13	00
10th.			
Brought into my warehouse			
My 5 hhd's pimento, containing 1535 lb. valued at 6 <i>d.</i> per lb.	38	07	6
And also my 5 hhd's sugar, containing 63 C. at 19 <i>s.</i> per C.	59	17	0
K. n. 2.	98	04	06

	l.	s.	d.
July 15th.			
Drawn my bill on <i>William Boyd</i> in <i>Jamaica</i> , payable to <i>Edward Dupper</i> , or order, for value due by ditto <i>Dupper</i> , at 10 days,	108	19	07
L. 2.			
22d.			
J. P. Shipped on board the <i>Dolphin</i> , consigned to N <sup>o</sup> 1. <i>John Perkins</i> merchant in <i>Hamburg</i> , to sell for my account, the goods following, marked 3. and numbered as per margin, viz.			
My 5 hhd's sugar, valued at	59	17	0
18 pieces calicoes, bought of <i>Jacob Ruffel</i> , at 2 <i>l.</i> 15 <i>s.</i> to pay at 6 months,	49	10	0
8 fother lead, presently bought for ready money, at 12 <i>l.</i> 18 <i>s.</i>	103	04	0
Paid custom and other charges,	14	06	8
G. n. 1.	226	17	08
30th.			
Received of <i>Edward Dupper</i> , in full for my bill on <i>William Boyd</i> ,	108	19	07
E. 4.			
August 3d.			
Received of <i>Nathaniel Napier</i> , in part for druggets,	62	00	00
E. 4.			
6th.			
Lent <i>Edward Harley</i> upon bond, for three months, at 5 per cent.	400	00	00
F. 2.			
10th.			
Received from on board the <i>Griffin</i> , <i>John Temple</i> matter, the following goods, to sell for account of <i>Herman Van Beek</i> , merchant in <i>Amsterdam</i> , viz. 18 C. flax, and 14 butts madder, each butt containing 12 C.			
Paid custom, freight, wharfage, portorage, &c.	14	12	05
M.			
17th.			
Sold <i>Herman Van Beek's</i> 14 butts madder, containing 168 C. at 2 <i>l.</i> 10 <i>s.</i> per C. for ready money,	420	00	00
N. 1.			
23d.			
Sold to <i>Thomas Freeman</i> , for account of <i>Herman Van Beek</i> , 18 C. flax at 3 <i>l.</i> to pay at six M <sup>o</sup> .	54	00	00
N. 2.			
Paid storage, brokerage, and other charges on <i>Herman Van Beek's</i> goods,	1	7	06
N. 4.			
My commission on 490 <i>l.</i> at 2 per cent. comes to	12	00	00
N. 4.			

	l.	s.	d.
<p>August 30th.</p> <p>HVB N<sup>o</sup> 1. By order of <i>Herman Van Beek</i>, I have shipped on board the <i>Weasle sloop, Thomas Dyke</i> master, bound for <i>Amsterdam</i>, the goods following, marked and numbered as per margin, viz.</p> <p>My 5hhds pymento, containing 1535 lb. which I value at 10d. per lb. } 63 19 2</p> <p>12 hhds tobacco, presently bought for ready money, containing 60 C. at 2½ d. per lb. } 62 10 0</p> <p>Paid custom and other charges, 7 18 2</p> <p>Due to <i>James Wright</i> for cooperage 0 12 8</p> <p>My commission on the whole, at 2½ per cent. } 3 07 6</p> <p style="text-align: right;">138 07 05</p> <p>O. n. 1. 3.</p> <p>31st.</p> <p>Paid <i>James Wright</i> in full for cooperage, } 0 12 0</p> <p>The abatement allowed by him is, 0 00 8</p> <p style="text-align: right;">0 12 08</p> <p>N. n. 2. O. n. 3.</p> <p>September 1st.</p> <p>Our ship the <i>Britannia</i> is arrived from <i>Barbadoes</i>, and <i>Mr Steel</i> has paid the owners in full for freight. My ¼ part, which I have received, is E. 10.</p> <p style="text-align: right;">72 10 00</p> <p>3d.</p> <p>Accepted <i>Herman Van Beek's</i> bill on me, payable to <i>William Sabin</i> at six days sight; the sum is P. 2. F. n. 4. &amp; 9.</p> <p style="text-align: right;">200 00 00</p> <p>8th.</p> <p>Remitted <i>Herman Van Beek</i> a bill of 584 guilders, drawn by <i>Joseph Buchan</i> on <i>Ralph Roger</i> merchant in <i>Amsterdam</i>, value paid here; exchange at 36s. 6d. is P. 4.</p> <p style="text-align: right;">53 06 08</p> <p>10th.</p> <p>Paid <i>William Sabin</i> in full for <i>Van Beek's</i> bill P. n. 1. F. n. 4. &amp; 9.</p> <p style="text-align: right;">200 00 00</p> <p>Received of <i>Jacob Spence</i> 6 months interest of 1000<i>l.</i> lent him, the principal being continued in his hands for another half-year; the sum received is E. 7.</p> <p style="text-align: right;">25 00 00</p> <p>22d.</p> <p>Received advice from <i>John Perkins</i> of <i>Hamburg</i>, That he hath received and disposed of my goods, the neat proceeds, as per account of sales, amounting to 405<i>l.</i> 5s. 1½d. <i>Flemish</i>, exchange at 34s. 5d. makes <i>Sterling</i> H. 2.</p> <p style="text-align: right;">2 5 10 00</p> <p>28th.</p> <p>Received from the commissioners of the customs the drawback on my 5 hhds sugar exported to <i>Hamburg</i>, G. n. 3.</p> <p style="text-align: right;">8 05 04 ½</p>			

	l.	s.	d.
<p>September 30th.</p> <p><i>John Perkins</i> hath remitted me in full, exchange at 34s. in bills on the following persons, viz.</p> <p>One, on <i>John Alston</i>, for 80 00 0</p> <p>One, on <i>Jacob Finch</i>, for 120 00 0</p> <p>One, on <i>Stephen Morden</i>, for 38 07 8½</p> <p style="text-align: right;">L. 5.</p> <p style="text-align: right;">238 07 08 ½</p> <p>October 4th.</p> <p><i>Edward Hopkins</i> and myself have agreed to go equal halves in 10 hhds tobacco, he to be manager; my half share, which I have paid him down, comes to Q. 1.</p> <p style="text-align: right;">60 00 00</p> <p>9th.</p> <p><i>Edward Hopkins</i> having disposed of our tobacco, has paid me my proportion of neat proceeds, as follows, viz.</p> <p>Paid me in money 27 07 4</p> <p>Given me a bill on <i>Richard Adison</i> for the rest } 45 00 0</p> <p style="text-align: right;">R. 1. n. 1.</p> <p style="text-align: right;">72 07 04</p> <p>Delivered to <i>Edward Hopkins</i>, 40 pieces cambrics, to sell for our account, each ¼, valued at 3<i>l.</i> per piece, Q. 2.</p> <p style="text-align: right;">120 00 00</p> <p>11th.</p> <p>Received of <i>Edward Hopkins</i>, in full for his half-share of 40 pieces cambrics, Q. n. 2.</p> <p style="text-align: right;">60 00 00</p> <p>20th.</p> <p><i>Edward Hopkins</i> has sold our cambrics for present money, and paid me my part of neat proceeds, as follows, viz.</p> <p>Given me 72lb. cloves, at 9s. 32 08 00</p> <p>The rest in money, 30 00 00</p> <p style="text-align: right;">62 08 00</p> <p style="text-align: right;">R. 1. n. 1.</p> <p>21st.</p> <p>Bought of <i>James Ward</i> 90 pieces stuffs, at 2<i>l.</i> 8s. to pay at 3 months, B. 3.</p> <p style="text-align: right;">216 00 00</p> <p>22d.</p> <p>Paid loss of a wager on a horse-race, F. 14.</p> <p style="text-align: right;">2 02 00</p> <p>Bought in company with <i>George Kent</i>, each one half, the ship <i>Phoenix</i>, for which we have paid down our respective shares to the owners, amounting to S. 2. n. 2.</p> <p style="text-align: right;">640 00 00</p> <p>25th.</p> <p>The carpenter has brought in his bill of repairs on the <i>Phoenix</i>, which I have paid, S. 3.</p> <p style="text-align: right;">16 10 00</p> <p>Mr <i>Jones</i> and company have freighted the <i>Phoenix</i>, for tear and wear of a voyage to <i>Cadiz</i>, at 22<i>l.</i> per month, and have thereupon advanced 1 month's freight, which I have received, T. 1. n. 1.</p> <p style="text-align: right;">22 00 00</p>			

	l.	s.	d.
October 25th. The Royal Exchange insurance-office has insured to us 600 <i>l.</i> on the <i>Phoenix</i> , outward and inward at 3 per cent. the premium, which I have paid, comes to,			18 00 00
S. 3.			
26th. Bought of <i>Richard Owen</i> , for account of <i>George Kent</i> and myself in company, each $\frac{1}{2}$ ,			
l. s.			
4 pipes sherry, at 26 <i>l.</i>	104	00	
5 pipes ditto, at 26 <i>l.</i> 10 <i>s.</i>	132	10	
Due on demand,			236 10 00
S. 1.			
27th. Adjusted accounts with <i>George Kent</i> , and received			
l. s. d.			
His half-share of my disbursements on the <i>Phoenix</i> ,	6	5	0
Received also his half-share of the price of 9 pipes sherry,	118	5	0
			124 10 00
U. 1.			
Paid <i>Richard Owen</i> , in full for sherry	236	10	00
S. 1. n.			
29th. Sold <i>Edward Turner</i> our 5 best pipes sherry, at 29 <i>l.</i>			
l. s.			
Received in part,	120	00	
Rest due on demand,	25	00	
			145 00 00
T. 1.			
November 1st. Sold our other 4 pipes sherry, for ready money, at 27 <i>l.</i> 12 <i>s.</i>			110 08 00
T. 1.			
Received of <i>Edward Turner</i> , in full for our sherry,	25	00	00
T. 1. n. 2.			
Paid carriage, cellar-rent, and other charges on our sherry,	3	02	00
S. 3. T. 3. n. 2.			
My commission on the whole, at $\frac{1}{2}$ per cent. amounts to	7	08	06
T. 3. n. 2.			
4th. Paid <i>George Kent</i> , in full for his half-share of neat proceeds on sherry,	122	08	09
U. 4.			
8th. Received from <i>Edward Harley</i> , in full of his bond dated 6th <i>August</i> last, with 3 months interest at 5 per cent.			
l. s.			
The principal is	400	00	
The interest comes to	5	00	
			405 00 00
E. 8.			

	l.	s.	d.
November 11th. Paid one year's rent of my dwelling-house, viz. from <i>Mart.</i> 1764 to <i>Mart.</i> 1765, F. 13.			40 00 00
12th.			
<i>George Evans</i> is broke, and I have compounded his debt of 300 <i>l.</i> at 12 <i>s.</i> per pound.			
l. s.			
The composition received is	180	00	
The discount is	120	00	
			300 00 00
E. 5.			
Received of <i>Nathaniel Niaper</i> , in full for druggets,			62 00 00
E. 4.			
15th. P. J. <i>Simon King</i> , <i>John Oker</i> , and myself, resolving to make an equal joint adventure, we have put into company what goods each of us have proper for the intended voyage, without regard to our due proportions, purposing to adjust that matter with money.			
l. s.			
<i>Simon King</i> , 80 pieces serge, at 5 <i>l.</i> 10 <i>s.</i>	440	00	
<i>John Oker</i> , 70 pieces frize, at 4 <i>l.</i>	280	00	
I have put in my 90 pieces stuffs, which I value at 2 <i>l.</i> 10 <i>s.</i>	225	00	
I have paid charges till on board,	27	10	
I have also paid <i>Simon Smith</i> and comp. for insuring 900 <i>l.</i> on our said adventure,	22	10	
			995 00 00
Shipped the whole on board the <i>Thistle</i> , Capt. <i>Bently</i> master, consigned to <i>Philip Jenkins</i> merchant in <i>Lisbon</i> , to sell for our account, being marked and numbered as per margin.			
V. 2. n. 2.			
17th. Upon adjusting accompts with <i>Simon King</i> and <i>John Oker</i> , there appears due to the former,			
l. s. d.			
From <i>John Oker</i> ,	51	13	4
And from me	56	13	4
Which we have paid, the total being			108 06 08
U. 4. & 7.			
22d. <i>Simon King</i> , <i>John Oker</i> , and myself, resolving further to trade in company, have bought of <i>George Wood</i> 18 tuns oil of <i>Gallipoly</i> , at 29 <i>l.</i> 10 <i>s.</i> due on demand,			531 00 00
S. 1.			
25th. <i>Simon King</i> , <i>John Oker</i> , and myself, have paid <i>George Wood</i> , in full for oil, as follows, viz.			
l. s.			
<i>S. King</i> has given him goods to the value of	120	0	
<i>John Oker</i> has counted with him for	200	0	
I have paid him the rest in money,	211	0	
			531 00 00
U. 8. S. 1. n.			

( 11 ) WASTE-BOOK.

WASTE-BOOK. ( 12 )

	l.	s.	d.
November 21st.			
Simon King has evened our accounts, by paying		l. s.	
To John Oker,		23	0
And to me,		34	0
U. 7. & 1.	57	00	00
30th.			
Sold James Fuller, 1 tun of our oil, to pay at 14 days.			30 00 00
T. 1.			
December 2d.			
Sold George Young, 7 tuns of our oil, at 30l. 10s.		l. s.	
Received in part,		113	10
Rest due in 10 days,		100	00
T. 1.	213	10	00
7th.			
Bartered 10 tuns of our oil, at 32l. for 12 pipes Canary wine, of the same value, viz.		l. s.	
6 pipes at 28l. 6s. 8d.		170	0
And 6 pipes at 25l.		150	0
T. 2.	320	00	00
13th.			
Received of George Young, in full for oil,			100 00 00
T. 1. n. 2			

	l.	s.	d.
December 18th.			
Sold our 6 pipes best Canary, for present money, at 29l. 12s.			177 12 00
T. 1.			
20th.			
James Fuller is broke, and we have compounded his debt of 30l. at 8s. per pound,		l. s.	
The composition which I have received is		12	0
The discount amounts to		18	0
T. 1. n. 2.	30	00	00
24th.			
Simon King, John Oker, and myself, have parted the remaining 6 pipes Canary equally among ourselves; which, valued at 25l. per pipe, comes to			150 00 00
T. 3.			
27th.			
The Phoenix is arrived from Cadiz, and Mr Jones has paid me, in full for freight,			22 00 00
T. 1. n. 1.			
28th.			
Sold our Phoenix to Mr Jones and company, to pay at 3 months,			700 00 00
T. 1.			
30th.			
Laid out for the use of my family, since the 1st of January last,			200 00 00
F. 13.			

( 1 )

J O U R N A L .

Edinburgh, the 1st of January 1769.

	l.	s.	d.
Sundries Drs to Stock, 13407 l.			
.1 Cash, for ready money, 12000 00 0	12000	00	0
.1 Linen, for 2000 yards, at } 2 s. 6 d. - - - - - }	250	00	0
.1 Indian chints, for 15 pieces, } at 24 l. 10 s. - - - - - }	367	10	0
.1 Ship Britannia, for $\frac{1}{2}$ cost, 348 10 0	348	10	0
.2 John Harris, per note on demand, 45 00 0	45	00	0
.2 Thomas Freeman, per bill due Feb. 2. 96 00 0	96	00	0
.2 George Evans, per bond at 5 per cent. 300 00 0	300	00	0
	13407	00	00
.2 Stock Dr to Sundries, 156 l.			
.2 To Joseph Martin, on demand, 36 00 0	36	00	0
.2 To Sir Isaac Crisp, due 1st of June, 120 00 0	120	00	0
	156	00	00
6th.			
.2 Cambrics Dr to Cash, 112 l.			
.1 Paid for 40 pieces, at 2 l. 16 s. - - - - -	112	00	00
10th.			
.2 Duroys Dr to John Vernon, 130 l.			
.3 Bought 100 pieces, at 26 s. to pay at 2 months, - - - - -	130	00	00
15th.			
.2 Joseph Martin Dr to Cash, 36 l.			
.1 Paid him in full, - - - - -	36	00	00
3.			
.3 Druggets Dr to Sundries, 195 l.			
.1 To Cash, in part for 26 pieces, at } 7 l. 10 s. - - - - - }	97	10	
.3 To Jacob Ruffel, for the rest, on demand, - - - - - }	97	10	
	195	00	00
21st.			
.3 Voyage to Jamaica Dr to Sundries, 223 l. 11 s. 4 d.			
.2 To Duroys, for 70 pieces, at } 26 s. - - - - - }	91	00	0
.3 To Jacob Green, for 6 pieces holland, at 18 l. to pay at 2 months. - - - - - }	108	00	0
.1 To Cash, paid charges and premium, - - - - - }	24	11	4
	223	11	04
30th.			
.3 Jacob Ruffel Dr to Cash, 97 l. 10 s.			
.1 Paid him in full for druggets, - - - - -	97	10	00

	l.	s.	d.
February 2d.			
.3 Broad Cloth Dr to Sundries, 675 l.			
.1 To Cash, in part, for 1000 yards, } at 13 s. 6 d. - - - - - }	330	00	
.2 To John Harris, for my bill on him, - - - - - }	45	00	
.3 To Edward Harley, for the rest at 3 months, - - - - - }	300	00	
	675	00	00
5th.			
.2 Cash Dr to Thomas Freeman, 96 l.			
.2 Received of him in full, - - - - -	96	00	00
16th.			
Sundries Drs to Cash, 765 l.			
.3 Kerseys, for 90 pieces, at 6 l. 540 00	540	00	
.3 Fuffians, for 120 pieces, at 37 s. 6 d. - - - - - }	225	00	
	765	00	00
25th.			
.1 Cash Dr to Druggets, 81 l. 10 s.			
.3 Received for 10 pieces, at 8 l. 3 s. - - - - -	81	10	00
March 1st.			
.4 George Young Dr to Broad Cloth, 280 l.			
.3 Sold him 400 yards, at 14 s. to pay at 1 M <sup>o</sup> . 280 00 00	280	00	00
4th.			
Sundries Drs to Kerseys, 571 l. 10 s.			
.1 Cash, in part for 90 pieces, at } 6 l. 7 s. - - - - - }	300	00	
.3 John Keil, for the rest, at 20 days, 271 10	271	10	
	571	10	00
10th.			
.3 John Vernon Dr to Cash, 130 l.			
.1 Paid him in full for duroys, - - - - -	130	00	00
17th.			
.4 Jacob Spencer Dr to Cash, 1000 l.			
.1 Lent him upon bond for 6 months, at 5 per cent. per ann. - - - - -	1000	00	00
17th.			
.4 Bills receivable Dr to Broad Cloth, 141 l. 13 s. 4 d.			
.3 Sold Jacob Preston 200 yards, at 14 s. 2 d. and received his bill on Henry Sidney for the whole, payable at sight, - - - - -	141	13	04
22d.			
Sundries Drs to Broad Cloth, 285 l. 16 s. 8 d.			
.4 Foreign Coin, for 26 moidores, } at 27 s. in part for 400 yds, } 35 02 0	35	02	0
.4 at 14 s. 3 $\frac{1}{2}$ d. - - - - - }			
.3 Cash, in British money, 150 14 8	150	14	8
Bills receivable, for Richard Stone's assignment on George Digby, for the rest, } 100 00 0	100	00	0
	285	16	08
23d.			
.3 Jacob Green Dr to Sundries, 108 l.			
.4 To Foreign Coin, for 26 moidores, } at 26 s. 6 d. - - - - - }	34	09	
.1 To Cash, for British money, 73 11	73	11	
	108	00	00
Paid him in full for holland.			

March



( 3 ) J O U R N A L .

J O U R N A L . ( 4 )

	l.	s.	d.
March 23d.			
.1 Cash Dr to Bills receivable, 141l. 13s. 4d.			
.4 Received of Henry Sidney, in full of Jacob Preston's bill,	141	13	04
April 1st.			
Sundries Drs to John Keil, 271l. 10s.			
		l.	s.
.1 Cash, in full for kerseys,		270	00
.3 Kerseys, abated him,		1	10
	271	10	00
6th.			
.1 Cash Dr to George Young, 280l.			
.4 Received of him in full for broad cloth,	280	10	00
10th.			
.4 Loskrans Dr to Indian Chints, 50l.			
.1 Received 40 pieces, at 25s. in barter, for 2 pieces, at 25l.	50	00	08
16th.			
Sundries Drs to Linen, 133l. 6s. 8d.			
		l.	s.
.4 Cochineal, for 1 C. valued at	108	16	0
.4 Cinnamon, for 64 lb. at 7s. 8d.	24	10	8
	133	06	00
.1 Received in barter for 1000 yards, at 2s. 8d.			
22d.			
Sundries Drs to Indian Chints, 148l. 10s.			
		l.	s.
.5 Muslin, for 8 bales, at 12l. 16s.	102	8	
.1 Cash, for the balance paid me,	46	2	
	148	00	00
.1 Received in barter for 6 pieces, at 24l. 15s.			
30th.			
.5 George Dennis Dr to Sundries, 187l. 10s.			
		l.	s.
.1 To Linen, for 100 yards, at 2s. 9d.	137	10	
.1 To Indian Chints, for 2 pieces, at 25l.	50	00	
	187	10	00
Delivered him in barter.			
Sundries Drs to George Dennis, 164l. 16s. 6d.			
		l.	s.
.5 Cotton, for 17 bags, containing } 42 C. 2 Q. neat, at 3l. 15s. } per C. } 159 07 6			
.5 Cloves, for 12 lb. at 9s. 1d.	5	09	0
	164	16	06
.5 Received of him in barter.			
May 3d.			
.3 Edward Harley Dr to Cash, 300l.			
.1 Paid him in full for broad cloth,	300	00	00
7th.			
.5 Suspense-accompt Dr to Druggets, 124l.			
.3 Sent Nathaniel Napier 16 pieces, desiring him to take them at 7l. 15s. or return them,	124	00	00
13th.			
.5 Refusal of Bargains Dr to Cash, 2l. 2s.			
.1 Paid to Simon Smart, as a penalty for refusing a bargain of Norwich stuffs,	2	02	00

	l.	s.	d.
May 18th.			
.5 John Jessop his accompt-current Dr to Sundries, 360l. 15s.			
.5 To George Dennis, for 8 tuns lead, } at 13l. 10s. to pay at 1 month, } 108 0			
.1 To Cash, for 7536 lb. tanned leather, } at 7d. with custom, insurance, &c. } 241 5			
.5 To George Aiton, for packing,	1	5	
.6 To Profit and Loss, for my commission,	10	5	
	360	15	00
22d.			
.5 George Aiton Dr to Cash, 1l. 5s.			
.1 Paid him in full for packing John Jessop's leather,			
			105 00
31st.			
.1 Cash Dr to John Jessop his accompt current, 200l.			
.5 Drawn my bill on him, for 960 dollars, at 50d. payable to George Stapleton, or order, value received,			
			200 00 00
June 3d.			
.3 John Vernon Dr to Profit and Loss, 200l.			
.6 Left me in legacy by Dr George Friend, and payable by ditto Vernon, his executor,			
			200 00 00
8th.			
.2 Sir Isaac Crisp Dr to Cash, 80l.			
.1 Paid him in part,			
			80 00 00
16th.			
.6 Nathaniel Napier Dr to Suspense accompt, 124l.			
.5 Writes me, that he keeps the 16 pieces druggets sent him the 7th of May last, promising to pay one half against the 1st of August, and the other half at Martinmas, the whole being,			
			124 00 00
18th.			
Sundries Drs to Voyage to Jamaica, 304l. 7s.			
		l.	s.
.6 Voyage from Jamaica, for goods } returned, and charges, } 195 07 5			
.6 William Boyd my accompt current, } for balance in his hands, } 108 19 7			
	304	07	00
22d.			
.5 George Dennis Dr to Cash, 85l. 6s. 6d.			
.1 Paid him in full			
			85 06 06
29th.			
.2 Sir Isaac Crisp Dr to Cash, 40l.			
.1 Paid him in full			
			40 00 00
July 2d.			
.7 Charges of merchandize Dr to Cash, 12l.			
.1 Paid shop-rent for 1/2 year, viz. from January 1. to July 1.			
			12 00 00
5th.			
.7 Charges of merchandize Dr to Cash, 2l. 12s. 8d.			
.1 Paid my shop keeper his bill of postage, and other charges,			
			2 12 08
9th.			
.6 Voyage from Jamaica Dr to Cash, 97l. 12s.			
.1 Paid freight, duty, and other charges here,			
			97 12 00
Sundries Drs to Voyage from Jamaica, 160l. 13s.			
		l.	s.
.1 Cash in part for 6 barrels indigo, containing 756 lb. at 4s. 3d. per lb. } 30 15			
.7 John Dyer, for the rest at six months,	80	00	
	160	13	00

2 B O O K - K E E P I N G .

( 5 ) J O U R N A L .

	l.	s.	d.
July 10th.			
Sundries Drs to Voyage from Jamaica, 98 l. 4 s. 6 d.			
Pimento, for 5 hogheads, containing 1535 lb. at 6 d. per lb.	38	07	6
Sugar, for 5 hogheads, containing 63 C. at 19 s. per C.	59	17	0
Brought into my warehouse. 15th.	98	04	06
Edward Dupper Dr to William Boyd my account-current, 108 l. 19 s. 7 d. Drawn my bill on him, payable to ditto Dupper, value due by him, at 10 days, 22d.	108	19	07
Voyage to Hamburg Dr to Sundries, 226 l. 17 s. 8 d.			
To Sugar, for 5 hogheads, valued at	59	17	0
To Jacob Russel, for 18 pieces callicoos, at 2 l. 15 s. to pay at 6 months,	49	10	0
To Cash, for 8 fother lead, at 12 l. 18 s. and charges at shipping,	117	10	8
	226	17	08
30th.			
Cash Dr to Edward Dupper, 108 l. 19 s. 7 d. Received of him, in full of my bill on William Boyd,	108	19	07
August 3d.			
Cash Dr to Nathaniel Napier, 62 l. Received his first moiety for druggets,	62	00	00
6th.			
Edward Harley Dr to Cash, 400 l. Lent him upon bond, for 3 months, at 5 per cent.	400	00	00
10th.			
Herman Van Beek his account of goods, Dr to Cash, 14 l. 12 s. 6 d. Paid custom, freight, and other charges on them,	14	12	06
17th.			
Cash Dr to Herman Van Beek his account of goods, 420 l. Received for his 14 butts madder, containing 168 C. at 2 l. 10 s. per C.	420	00	00
23d.			
Thomas Freeman Dr to Herman Van Beek his account of goods, 54 l. For his 18 C. flax, at 3 l. to pay at 6 months,	54	00	00
Herman Van Beek his account of goods Dr to Cash, 1 l. 7 s. 6 d. Paid storage, brokerage, &c.	1	07	06
Herman Van Beek his account of goods Dr to Profit and Loss, 12 l. 5 s. For my commission at 2½ per cent.	12	05	00

J O U R N A L . ( 6 )

	l.	s.	d.
August 30th.			
Herman Van Beek his account current Dr to Sundries, 138 l. 7 s. 6 d.			
To Pimento, for 5 hogheads, containing 1535 lb. which I value at 10 d. per lb.	63	19	2
To Cash, for 12 hogheads tobacco, containing 60 C. at 2½ d. per lb. and charges,	70	08	2
To James Wright, for cooerage,	0	12	8
To Profit and Loss, for my commission at 2½ per cent.	3	07	6
	138	07	06
31st.			
James Wright Dr to Sundries, 12 s. 8 d.			
To Cash, in full,	12	0	
To H. Van Beek his account-current, abated,	00	8	
	0	12	08
September 1st.			
Cash Dr to Ship Britannia, 72 l. 10 s. Received my ¼ of freight from Mr Steel,	72	10	00
3d.			
Herman Van Beek his account-current Dr to Bills payable, 200 l. Accepted his bill on me payable to William Sabin at 6 days,	200	00	00
8th.			
Herman Van Beek his account-current Dr to Cash, 53 l. 6 s. 8 d. Remitted him 584 guilders in Joseph Buchan's bill on Ralph Roger, value paid here,	53	06	08
10th.			
Bills payable Dr to Cash, 200 l. Paid William Sabin, in full of Van Beek's bill on me,	200	00	00
11th.			
Cash Dr to Profit and Loss, 25 l. Received 6 months interest of 1000 l. lent Jacob Spencer,	25	00	00
22d.			
John Perkins my account current Dr to Voyage to Hamburg, 235 l. 10 s. Received advice that he hath sold my goods, the neat proceeds amounting to 405 l. 5 s. 1½ d. Flemish, exchange at 34 s. 5 d. makes Sterling,	235	10	00
28th.			
Cash Dr to Voyage to Hamburg, 8 l. 5 s. 4½ d. Received drawback on my 5 hogheads sugar exported,	8	05	04½
30th.			
Bills receivable Dr to John Perkins my account-current, 238 l. 7 s. 8½ d. Remitted to me in full of 405 l. 5 s. 1½ d. exchange at 34 s. in bills, viz.			
One, on John Alston, for	80	00	0
One, on Jacob Finch, for	120	00	0
One, on Stephen Morden, for	38	07	8½
	238	07	08½

( 7 ) J O U R N A L .

J O U R N A L . ( 8 )

	l.	d.	s.
October 4th.			
.8 Edward Hopkins my accmpt in company Dr to Cash, 60l.			
.1 Paid him my half share of 10 hogheads tobacco in his hands,	60	00	00
9th.			
Sundries Drs to Edward Hopkins my accmpt in company, 72l. 7s. 4d.			
	l.	s.	d.
.1 Cash, received in money, -	27	07	4
.4 Bills receivable, for one on R. Ad-	45	00	0
.8 dison,			
	72	07	04
Sundries Drs to Cambrics, 120 l.			
	l.	s.	
.8 Edward Hopkins my accmpt in company, for my half share of 40 pieces, at 3l.	60	00	
.8 Edward Hopkins my accmpt proper, for his half share,	60	00	
	120	00	00
11th.			
.1 Cash Dr to Edward Hopkins my accmpt proper, 60l.			
.8 Received for his half share of cambrics,	60	00	00
20th.			
Sundries Drs to Edward Hopkins my accmpt in company, 62l. 8s.			
	l.	s.	
.5 Clowes, for 72 lb. at 9 s.	32	8	
.1 Cash, received in money, -	30	0	
	62	08	00
21st.			
.8 Stuffs Dr to James Ward, 216l.			
.8 Bought 90 pieces, at 2l. 8s. to pay at 3 months,	216	00	00
22d.			
.6 Profit and Loss Dr to Cash, 2 l. 2 s.			
.1 Paid loss of a wager on a horse-race,	2	02	00
Ship Phenix in company with George Kent Dr to Sundries, 640l.			
	l.	s.	
.1 To cash, for my half share,	320	0	
.8 To George Kent his accmpt in company, for his half share,	320	0	
	640	00	00
25th.			
.8 Ship Phenix in company with George Kent Dr to Cash, 16l. 10s.			
.1 Paid the carpenter his bill of repairs,	16	10	00
George Kent his accmpt proper Dr to ditto Kent his accmpt in company, 8l. 5s.			
.8 For his half share of repairs,	8	05	00
Cash Dr to Ship Phenix in Company with George Kent, 22 l.			
.8 Received 1 month's freight,	22	00	00
George Kent his accmpt in company Dr to ditto his accmpt proper, 11 l.			
.9 For his half share of 1 month's freight received,	11	00	00

	l.	s.	d.
October 25th.			
.8 Ship Phenix in company with George Kent Dr to Cash, 18 l.			
.9 Paid premium for insuring 600l. to and from Cadiz,	18	00	00
George Kent his accmpt proper Dr to ditto his accmpt in company, 9l.			
.8 For his half share of premium,	9	00	00
26th.			
.9 Sherry in company with George Kent Dr to Richard Owen, 236 l. 10s.			
.9 For 9 pipes, viz. 4 at 26l. and 5 at 26l. 10s. due on demand,	236	10	00
George Kent his accmpt proper Dr to ditto his accmpt in company, 118 l. 5s.			
.8 For his half share of 9 pipes sherry,	118	05	00
27th.			
.9 Cash Dr to George Kent his accmpt proper, 124 l. 10s.			
.9 Received of him his half share of my disbursements on the Phenix, and also his half share of the price of 9 pipes sherry,	124	10	00
Richard Owen Dr to Cash, 236 l. 10s.			
.9 Paid him in full for sherry,	236	10	00
29th.			
Sundries Drs to Sherry in Company with George Kent, 145 l.			
	l.	s.	
.9 Cash, in part for our 5 best pipes, at 29 l.	120	00	
.9 Edward Turner, for the rest, on demand,	25	00	
	145	00	00
George Kent his accmpt in company Dr to ditto his accmpt proper, 72 l. 10s.			
.9 For his half share of 5 pipes sherry sold Edward Turner, at 29 l.	72	10	00
November 1st.			
.9 Cash Dr to Sherry in company with George Kent, 110 l. 8s.			
.9 Received for 4 pipes, at 27l. 12s.	110	08	00
George Kent his accmpt in company Dr to ditto his accmpt proper, 55 l. 4s.			
.9 For his half share of 110l. 8s. received for 4 pipes sherry,	55	04	00
Cash, Dr to Edward Turner, 25 l.			
.9 Received of him in full for sherry,	25	00	00
Sherry in company with George Kent Dr to Cash, 3 l. 2s.			
.9 Paid carriage, cellar-rent, &c.	3	02	00
George Kent his accmpt proper Dr to ditto his accmpt in company, 1 l. 11s.			
.8 For his half share of carriage, cellar-rent, &c.	1	11	00

November

		l.	s.	d.
	November 1st.			
.9	Sherry in company with George Kent Dr to Profit and Loss, 7l. 8s. 6d.			
.6	For my commission, at 1½ per cent.	7	08	06
.9	George Kent his account proper Dr to ditto his account in company, 3l. 14s. 3d.			
.8	For his half share of my commission,	3	14	03
	4th.			
.9	George Kent his account proper Dr to Cash, 122l. 8s. 9d.			
.9	Paid him in full for his half share of neat proceeds on sherry,	122	08	09
	8th.			
.9	Cash Dr to Sundries, 405l.			
			l.	s.
.3	To Edward Harley, for principal lent him the 6th of August last,	400	00	00
.6	To Profit and Loss, for 3 months interest, at 5 per cent.	5	00	00
		405	00	00
	11th.			
.9	House expences Dr to Cash, 40l.			
.9	Paid one year's rent of my dwelling-house,	40	00	00
	12th.			
	Sundries Dis to George Evans, 300l.			
			l.	s.
.9	Cash, received in composition of his debt, 180	180	00	00
.6	Profit and Loss, abated him,	120	00	00
		300	00	00
	12th.			
.6	Cash Dr to Nathaniel Napier, 62l.			
.6	Received of him in full,	62	00	00
	15th.			
.9	Voyage to Lisbon in company with Simon King and John Oker Dr to Sundries, 995l.			
			l.	s.
.10	To Simon King his account proper, for 80 pieces serge, at 5l. 10s.	440	00	00
.10	To John Oker his account proper, for 70 pieces frize, at 4l.	280	00	00
.8	To Stuffs, for 90 pieces, at 2l. 10s.	225	00	00
.5	To Cash, for charges and premium,	50	00	00
		995	00	00
.10	Simon King his account proper Dr to ditto his account in company, 331l. 13s. 4d.			
.10	For his ½ share of the voyage to Lisbon,	331	13	04
.10	John Oker, ditto,	331	13	04
	17th.			
.10	Simon King his account proper Dr to Sundries, 108l. 6s. 8d.			
			l.	s.
.10	To J. Oker his account proper paid by him,	51	13	4
.5	To Cash, paid by me,	56	13	4
		108	06	08

		l.	s.	d.
	November 22d.			
.10	Oil in company with Simon King and John Oker Dr to George Wood, 531l.			
	Bought 18 tuns, at 29l. 10s. due on demand,	531	00	00
.10	Simon King his account proper Dr to ditto his account in company, 177l.			
.10	For his ½ share of 18 tuns oil,	177	00	00
.10	John Oker, ditto,	177	00	00
	25th.			
.10	George Wood Dr to Sundries, 531l.			
			l.	s.
.10	To Simon King his account proper, paid by him,	120	00	00
.10	To John Oker his account proper, paid by him,	200	00	00
.9	To Cash, paid by me,	211	00	00
		531	00	00
	Sundries Drs to S. King his account proper, 57l.			
			l.	s.
.10	John Oker his account proper, paid to him,	23	00	00
.9	Cash, paid to me,	34	00	00
		57	00	00
	30th.			
.10	James Fuller Dr to Oil in company with S. King and J. Oker, 30l.			
.10	Sold him 1 tun, to pay at 14 days,	30	00	00
.10	Simon King his account in company Dr. to ditto his account proper, 10l.			
.10	For his ½ share,	10	00	00
.10	John Oker, ditto,	10	00	00
	December 2d.			
.10	Sundries Drs to Oil in company with S. King and J. Oker, 213l. 10s.			
			l.	s.
.9	Cash, in part for 7 tuns, at 30l. 10s. 113 10	113	10	00
.4	George Young, for the rest, at 10 days, 100 00	100	00	00
		213	10	00
.10	Simon King his account in company Dr to ditto his account proper, 71l. 3s. 4d.			
.10	For his ½ share of seven tuns of oil sold,	71	03	04
.10	John Oker, ditto,	71	03	04
	7th.			
.11	Canary in company with S. King and J. Oker Dr to Oil in company with ditto, 320l.			
.10	Received 12 pipes, viz. 6 pipes at 28l. 6s. 8d. and 6 pipes at 25l. in barter for 10 tuns, at 32l.	320	00	00
	13th.			
.9	Cash Dr to George Young, 100l.			
.4	Received of him, in full for oil in company,	100	00	00

( 11 ) J O U R N A L .

J O U R N A L . ( 12 )

	l.	s.	d.
December 18th.			
.9 Cash Dr to Canary in company with Simon King and John Oker, 177l. 12s. Received for 6 pipes, at 29l. 12s.	177	12	00
.10 Simon King his accmpt in company Dr to ditto his accmpt proper, 59l. 4s. For his $\frac{1}{3}$ share of 177l. 12s. received for Canary,	59	04	00
.10 John Oker, ditto,	59	04	00
20th.			
Sundries Drs to James Fuller, 30l.			
.9 Cash, received in composition of his debt,	12	00	
.10 Oil in company with S. King and John Oker, abated him,	18	00	
	30	00	00
.10 Simon King his accmpt proper Dr to ditto his accmpt in company, 6l. For his $\frac{1}{3}$ share of 18l. abated	6	00	00
.10 John Oker, ditto,	6	00	00
24th.			
Sundries Drs to Canary in company with S. King and J. Oker, 150l.			
.10 S. King his accmpt in company, for 2 pipes taken to himself, as his share of what remains,	50	00	
.10 J. Oker his accmpt in company, for ditto,	50	00	
.11 Canary, for 2 pipes retained, as my share,	50	00	
	150	00	00

	l.	s.	d.
December 27th.			
.9 Cash Dr to Ship Phenix in company with George Kent, 22l. Received in full for freight,	22	00	00
.8 George Kent his accmpt in company Dr to ditto his accmpt proper, 11l. For his half share of 22l. received as freight,	11	00	00
28th.			
.11 Mr Jones and company Dr to Ship Phenix in company with George Kent, 700l. Sold ditto ship, to pay at 3 months,	700	00	00
.8 George Kent his accmpt in company Dr to ditto his accmpt proper, 350l. For his half share,	350	00	00
30th.			
.9 House expences Dr to Cash, 200l. Expended since the 1st of January last,	200	00	00

## L E D G E R, 1769.

## T H E I N D E X, O R A L P H A B E T.

A.	B.	C.	D.	E.	F.
Aiton (George) 5	Broad cloth 3 Bills receivable 4 Boyd (William) } my acct-curt } 6 Bills payable 8 Balance 11	Cash 1-9 Chints (Indian) 1 Crisp (Sir Isaac) 2 Cambrics 2 Cochineal 4 Cinnamon 4 Cotton 5 Cloves 5 Charges of mer- } chandize } 7 Canary in comp. 11 Canary 11	Duroys 2 Druggets 3 Dennis (George) 5 Dyer (John) 7 Dupper (Edward) 7	Evans (George) 2	Freeman (Thom.) 2 Fustians 3 Foreign coin 4 Fuller (James) 10
Green (Jacob) 3	Harris (John) 2 Harley (Edward) 3 Hopkins (Edw.) } my accompt in } 8 comp. } Hopkins (Edw.) } my acct proper } 8 Houfe-expences 9	Jeffop (John) his } acct current } 5 Jones (Mr) and } company } 11	Kerseys 3 Keil (John) 4 Kest (George) } his accompt } 8 in comp. } Kest (Geo.) his } acct proper } 9 King (Simon) } his accompt } 10 proper } King (Simon) } his accompt } 10 in comp. }	Linen 1 Lockrams 4	Martin (Joseph) 2 Mullin 5
Napier (Nath.) 6	Owen (Richard) 9 Oker (John) his } acct proper } 10 Oker (John) his } acct in comp. } 10 Oil in company 10	Profit and Loss 6 Pymonto 7 Perkins (John) } my acct-curt } 7		Ruffel (Jacob) 3 Refusal of bargains 5	Ship Britannia 1 Stock 2 Spencer (Jacob) 4 Suspense-acct 5 Sugar 7 Stuffs 8 Ship Phoenix in } company } 8 Sherry in comp. 5
Turner (Edward) 9	Vernon (John) 3 Voyage to Jam. 3 Voy. from Jam. 6 Voy. to Hamburg 7 Van Beek (H.) his } acct of goods } 7 Van Beek his ac- } compt on time } 7 Van Beek his ac- } compt-current } 7 Voy. to Lisbon } in company } 9	Wright (James) 8 Ward (James) 8 Wood (George) 10		Young (George) 4	

(1) LEDGER.

LEDGER. (1)

No			Fo	l. s. d.	
	Cash,	Dr			
1769					
Jan. 1	To Stock, for ready money,	-	2	1200	00 00
Feb. 5	To Thomas Freeman, received in full,	-	2	96	00 00
25	To Druggets, for 10 pieces, at 8l. 3s.	-	3	81	10 00
Mar 4	To Kerseys, in part for 90 pieces, at 6l. 7s.	-	3	300	00 00
27	To Broad Cloth, in part for 400 yds,	-	3	150	14 08
23	To Bills receivable of Henry Sidney in full,	-	4	141	13 04
Apr. 1	To John Keil, in full for kerseys,	-	4	27	00 00
6	To George Young, in full for broad cloth,	-	4	28	00 00
22	To Indian chints, a balance in barter,	-	1	46	02 00
May 31	To J. Jessop his acct current,	-	5	20	00 00
July 9	To Voyage from Jamaica, in part for indigo,	-	6	80	13 00
30	To Edward Dupper, in full of my bill,	-	7	108	19 07
Aug 3	To Nathaniel Napier, in part for druggets,	-	6	62	00 00
17	To H. V. Beek his acct of goods,	-	7	420	00 00
Sept. 1	To Ship Britannia, for freight,	-	1	72	10 00
10	To Profit and Loss, for 6 months interell of 1000l.	-	6	25	00 00
28	To Voyage to Hamburg, for drawback on sugar,	-	7	80	5 04 1/2
Oct. 9	To Edward Hopkins my acct in company,	-	8	27	07 04
11	To Edward Hopkins my acct proper,	-	8	60	00 00
20	To Edward Hopkins my acct in company,	-	8	30	00 00
25	To Ship Phenix in company, for 1 month's freight,	-	8	22	00 00
				14482	15 03 1/2
2					
	<b>Linen,</b>	<b>Dr</b>			
1769					
Jan. 1	To Stock, at 2s. 6d. for	Yards. 2000	2	250	00 00
	To Profit and Loss, gained,	-	6	20	16 08
				270	16 08
3					
	<b>Indianchints,</b>	<b>Dr</b>			
1769					
Jan. 1	To Stock, at 24l. 10s. for	Pieces 15	2	367	10 00
	To Profit and Loss, gained,	-	6	3	10 00
				371	00 00
4					
	<b>Ship Britannia,</b>	<b>Dr</b>			
1769					
Jan. 1	To Stock, for 2/3 part,	-	2	348	10 00
	To Profit and Loss, gained,	-	6	72	10 00
				421	00 00

No			Fo	l. s. d.	
	Contra,	Cr			
1769					
Jan. 6	By Cambrics, for 40 pieces, at 2l. 16s.	-	2	112	00 00
15	By Joseph Martin, in full,	-	2	36	00 00
15	By Druggets, in part for 26 pieces, at 7l. 10s.	-	3	97	10 00
21	By Voy. to Jamaica, paid charges and prem.	-	3	24	11 04
30	By J. Ruffel, in full for druggets,	-	3	97	10 00
Feb. 2	By Broad Cloth, in part for 1000 yds, at 13s. 6d.	-	3	330	00 00
16	By Sundries, as per Journal,	-	3	765	00 00
Mar 10	By John Vernon, in full for duroys,	-	3	130	00 00
	By J. Spencer, lent him for 6 M <sup>o</sup> , at 5 per c.	-	4	1000	00 00
23	By Jacob Green, in part for holland,	-	4	73	11 00
May 3	By Edward Harley, in full,	-	3	300	00 00
13	By Refusal of bargains,	-	5	2	02 00
18	By J. Jessop his acct-curt. for leather, &c.	-	5	241	04 00
22	By George Aiton, in full,	-	5	1	05 00
June 8	By Sir Isaac Grisp, in part,	-	2	80	00 00
22	By George Dennis, in full	-	5	85	06 06
29	By Sir Isaac Grisp, in full,	-	2	40	00 00
July 2	By Charges of mer. paid 1/2 year's shop-rent,	-	7	12	00 00
5	By Charges of mer. paid postage, &c.	-	7	2	12 08
9	By Voyage from Jamaica, for charges paid,	-	6	97	12 00
22	By Voy. to Hamburg, for lead and charges,	-	7	117	10 03
Aug. 6	By Edward Harley, lent him at 5 per cent.	-	3	400	00 00
10	By H. V. Beek his acct of goods, for charges,	-	7	14	12 00
23	By H. V. Beek his acct of goods,	-	7	1	07 06
30	By H. V. Beek his acct-current, for tobacco,	-	7	70	08 02
31	By James Wright, in full,	-	8	0	12 00
Sept. 8	By H. V. Beek his acct-curt, remitted him,	-	7	53	08 08
10	By Bills Payable,	-	8	200	00 00
Oct. 4	By Edward Hopkins my acct in company,	-	8	60	00 00
22	By Profit and Loss, paid loss of a wager,	-	6	2	02 00
	By Ship Phenix in company, for my 1/2 share,	-	8	320	00 00
25	By Ship Phenix in company, paid repairs,	-	8	16	10 00
	By New acctpt.	-	9	969	00 03 1/2
				14482	15 03 1/2
	<b>Contra,</b>	<b>Cr</b>			
1769					
Apr. 16	By Sundries, in bart. at 2s. 8d. for	Yards. 1000	132	6	08
30	By George Dennis, at 2s. 9d. for	1000	197	10	00
		2000	270	16	08
	<b>Contra,</b>	<b>Cr</b>			
1769					
Apr. 10	By Lockrams, in barter, at 25l. for	Pieces -	4	50	00 00
22	By Sund. in bart. at 24l. 15s. for	-	6	148	10 00
30	By George Dennis, at 25l.	-	5	50	00 00
	By Balance, remaining at 24l. 10s.	-	5 11	122	10 00
			15	371	00 00
	<b>Contra,</b>	<b>Cr</b>			
1769					
Sept. 1	By Cash, for my 2/3 of freight,	-	1	72	10 00
	By Balance, for my 1/2 remaining,	-	11	348	10 00
				421	00 00





B O O K - K E E P I N G .

( 3 ) L E D G E R .

L E D G E R . ( 3 . )

N <sup>o</sup>		Dr		Fo	l.	s.	d.
1769	John Vernon,	Dr					
Mar 10	To Cash, paid him in full,	-		11	30	00	00
June 3	To Profit and Loss, for Dr Friend's legacy,	-		6	20	00	00
					3	30	00
1769	Druggets,	Dr	Pieces.				
Jan. 15	To Sundries, at 7l. 10s. for		26	6	19	00	00
	To Profit and Loss, gained,		-		10	10	00
					2	05	10
1769	Jacob Ruffel,	Dr					
Jan. 30	To Cash, paid him in full,	-		1	97	10	04
	To Balance, due to him,	-		11	49	10	08
					1	47	00
1769	Voyage to Jamaica,	Dr					
Jan. 23	To Sundries, as per Journal,	-		2	23	12	00
	To Profit and Loss, gained,	-		6	80	15	00
					3	04	07
1769	Jacob Green,	Dr					
Mar 23	To Sundries, paid him in full,	-		1	08	00	00
1769	Broad Cloth,	Dr	Yards.				
Feb. 2	To Sundries, at 13s. 6d. for		1000	6	75	00	00
	To Profit and Loss, gained		-	6	32	10	00
					7	07	10
1769	Edward Harley,	Dr					
May 2	To Cash, paid him in full,	-		1	30	00	00
Aug. 6	To Cash, lent him at 5 per cent.	-		1	40	00	00
					7	00	00
1769	Kerseys,	Dr	Pieces.				
Feb. 16	To Cash, at 6l. for		90	1	54	00	00
Apr. 1	To John Keil, abated		-	4	1	10	00
	To Profit and Loss, gained,		-	6	30	00	00
					5	71	10
1769	Fustians,	Dr	Pieces.				
Feb. 16	To Cash, at 37s. 6d. for		120	1	22	50	00

	Cr		Fo	l.	s.	d.
1769	Contra,	Cr				
Jan. 10	By Duroys, to pay at 2 months,	-	3	13	00	00
	By Balance, due by him,	-	11	20	00	00
				3	30	00
1769	Contra,	Cr	Pieces.			
Feb. 25	By Cash, at 8l. 3s. for		10	8	1	00
May 7	By Suspense-accompt, at 7l. 15s. for		16	5	12	00
			26	2	05	10
1769	Contra,	Cr				
Jan. 15	By Druggets, on demand,	-	3	97	10	00
July 22	By Voyage to Hamburg, due at six M <sup>o</sup> .	-	7	49	10	00
				1	47	00
1769	Contra,	Cr				
June 18	By Sundries, as per Journal,	-	3	04	07	00
1769	Contra,	Cr				
Jan. 21	By Voyage to Jamaica, to pay at 2 M <sup>o</sup> .	-	3	108	00	00
1769	Contra,	Cr	Yards.			
Mar 1	By George Young, at 14s. for		400	4	28	00
17	By Bills receivable, at 14s. 2d. for		200	4	14	13
22	By Sundries, at 14s. 3½d. for		400	2	85	16
			1000	7	07	10
1769	Contra,	Cr				
Feb. 2	By Broad Cloth, due at 3 months,	-	3	30	00	00
Nov. 8	By Cash, for principal,	-	9	40	00	00
				7	00	00
1769	Contra,	Cr	Pieces.			
Mar 4	By Sundries, at 6l. 7s. for		90	5	71	10
1769	Contra,	Cr	Pieces.			
Feb. 16	By Balance, remain. at 37s. 6d.		120	1	22	50

B O O K - K E E P I N G .

( 4 ) L E D G E R .

L E D G E R . ( 4 )

N <sup>o</sup>		Dr	Cr	l.	s.	d.
1769	George Young,	Dr				
Mar 1	To Broad Cloth, to pay at 1 month,		3	28	00	00
Dec. 2	To Oil in company, due at 10 days,		10	100	00	00
				80	00	00
1769	John Keil,	Dr				
Mar 4	To Kerseys, to pay at 20 days,		3	27	10	00
1769	Jacob Spencer,	Dr				
Mar 10	To Cash, lent him at 5 per cent.		11	000	00	00
1769	Bills receivable,	Dr				
Mar 17	To Broad Cloth, for 1 on Henry Sidney,		3	14	13	04
Mar 22	To Broad Cloth, for 1 on George Digby,		3	100	00	00
Sept. 30	To J. Perkins my accmpt-current, for		8			
	1 on John Alston, L. 80 00 00					
	1 on Jacob Finch, 120 00 00					
	1 on Stephen Morden, 38 07 08½			23	8	8½
Oct. 9	To Ed. Hopkins my accmpt in comp. for 1 on Rich. Addison,		8	45	00	00
				52	51	00½
1769	Foreign coin,	Dr				
Mar 12	To Broad Cloth at 27s. for	Moidores. 26	3	35	02	00
1769	Lockrams,	Dr				
Apr. 10	To Indian Chints, in barter at 25s.	Pieces. 40	1	50	00	00
1769	Cochineal,	Dr				
Apr. 16	To Linen, in barter,	C. 1	1	108	16	00
1769	Cinnamon,	Dr				
Apr. 16	To Linen, in barter at 7s. 8d.	lb. 64	1	24	00	08

	Cr	Dr	l.	s.	d.
1769	Contra,	Cr			
Apr. 6	By Cash, received in full,		1	28	00
Dec. 13	By Cash, received in full,		9	100	00
				38	00
1769	Contra,	Cr			
Apr. 1	By Sundries, as per Journal,			27	10
1769	Contra,	Cr			
By Balance, due by him,			11	1000	00
1769	Contra,	Cr			
Mar 23	By Cash, received of Henry Sidney in full,		1	14	13
	By Balance remaining,				
	1 on George Digby, L. 100 00 00				
	1 on J. Alston, 80 00 00				
	1 on J. Finch, 120 00 00				
	1 on Stephen Morden, 38 07 08½			38	07
	1 on Rich. Addison, 45 00 00			8	8½
				52	51
1769	Contra,	Cr			
Mar 23	By Jacob Green, at 26s. 6d. for	Moidores. 26	3	34	09
	By Profit and Loss, lost,	—	6	01	30
				35	02
1769	Contra,	Cr			
By Balance remaining, at 25s.		Pieces. 40	11	50	00
1769	Contra,	Cr			
By Balance remaining,		C. 1	11	108	16
1769	Contra,	Cr			
By Balance, remain. at 7s. 8d.		lb. 64	11	24	00

B O O K - K E E P I N G .

( 5 ) L E D G E R .

L E D G E R . ( 5 )

N <sup>o</sup>		Dr		Fo	l.	s.	d.
1769	Apr. 22	Muslin,	Dr	Bales.			
		To Indian Chints, at 12 l. 16 s.		8	11	02	08 00
		for - - - - -					
1769	Apr. 30	George Dennis,	Dr				
		To Sundries, as per Journal,		187	10	00	
	June 22	To Cash, paid him in full,		1	85	06	06
							272 16 06
1769	Apr. 30	Cotton,	Dr	C.Q.			
		To G. Dennis, at 3 l. 15 s. per C.		42	2	5	159 07 06
1769	Apr. 20	Cloves,	Dr	lb.			
		To George Dennis, at 9 s. 1 d. for		12	5		5 09 00
	Oct. 30	To E. Hopkins, my accmpt in		72	8		32 08 00
		company, at 9 s. for - - -					84 37 17 00
1769	May 7	Suspense-accmpt,	Dr				
		To Druggets, sent Nathaniel Napier,		3	124	00	00
		16 pieces,					
1769	May 13	Refusal of Bargains,	Dr				
		To Cash, paid penalty for refusing Nor-		1			2 02 00
		wich stuffs,					
1769	May 18	John Jeffop his acct-curt.	Dr				
		To Sundries, as per Journal,		360	15	00	
1769	May 22	George Aiton,	Dr				
		To Cash, paid him in full,		1	1		5 00

		Cr		Fo	l.	s.	d.
		Contra,	Cr	Bales.			
		By Balance, remaining, at		8	11	02	08 00
		12 l. 16 s. - - -					
1769	Apr. 30	Contra,	Cr				
		By Sundries, as per Journal,		164	16	06	
	May 18	By J. Jeffop his acct-curt, at 1 month,		5	108	00	00
							272 16 06
		Contra,	Cr	C.Q.			
		By Balance, remaining, at 3 l. 15 s.		42	2	11	159 07 06
		Contra,	Cr	lb.			
		By Balance, remaining, at 9 s. 1 d.		12	11		5 09 00
		and at 9 s.		72			32 08 00
				84			37 17 00
		Contra,	Cr				
		By Nathaniel Napier,		6	124	00	00
		Contra,	Cr				
		By Profit and Loss, lost,		6			2 02 00
		Contra,	Cr				
		By Cash, for my bill, value received,		1	200	00	00
		By Balance, due by him,		11	160	15	00
							360 15 00
		Contra,	Cr				
		By J. Jeffop his acct-curt. for packing,		5			1 05 00

N <sup>o</sup>		Profit and Loss, -		Dr		Fol. l. s. d.		Contra,		Cr		Fol. l. s. d.				
1769	33															
Oct. 22	1769	To Cash, paid los of wager,	-	-	1	202	00	1769	By J. Jessop his accmpt current, for my commission,	-	-	5	1005	00		
Nov. 12	1769	To George Evans, abated,	-	-	2	120	00	May 18	By John Vernon, for a legacy,	-	-	3	200	00		
		To Foreign Coin, lost,	-	-	4	0	30	June 3	By H. V. Beek his accmpt of goods, for my commission,	-	-	7	1205	00		
		To Refusal of Bargains,	-	-	5	202	00	Aug. 23	By H. V. Beek his accmpt-current, for commission, at 2½,	-	-	7	307	06		
		To Voyage from Jamaica,	-	-	6	34	01	30	By Cash, for 6 months int. of 1000 l.	-	-	1	25	00		
		To Charges of merchandize,	-	-	7	14	12	Sept. 10	By Sherry in comp. for my commission,	-	-	9	7	08		
		To House-expences,	-	-	9	24	00	Nov. 1	By Cash, for 3 months interest of 400 l.	-	-	9	5	00		
		To Stock, neat gain since 1st Jan. last.	-	-	2	23	15	8	By Linen, gained,	-	-	1	20	16		
									By Indian Chints, gained,	-	-	1	3	10		
									By Ship Britannia, gained,	-	-	1	72	10		
									By Cambrics, gained,	-	-	2	8	00		
									By Druggets, gained,	-	-	3	10	10		
									By Voyage to Jamaica, gained,	-	-	3	80	15		
									By Broad Cloth, gained,	-	-	3	32	10		
									By Kerseys, gained,	-	-	3	30	00		
									By Pymonto, gained,	-	-	7	25	11		
									By Voyage to Hamburg, gained,	-	-	7	16	17		
									By John Perkins my accmpt-current,	-	-	8	2	17		
									By Ed. Hopkins my acct in comp. gained,	-	-	8	14	15		
									By Stuffs, gained,	-	-	8	9	00		
									By Ship Phoenix in company, gained,	-	-	8	34	15		
									By Sherry in company, gained,	-	-	9	4	03		
									By Oil in company, gained,	-	-	10	4	16		
									By Canary in company, gained,	-	-	11	2	10		
													637	06	10	
	39															
		Nathaniel Napier,							Contra,							
1769																
June 16	1769	To Suspense-accompt, 1st August and Martinmas,	-	-	5	124	00	Aug. 3	By Cash, in part,	-	-	1	62	00		
								Nov. 12	By Cash, in full,	-	-	9	62	00		
														124	00	
	40															
		Voyage from Jamaica,							Contra,							
1769																
June 18	1769	To Voyage to Jamaica, for returns,	-	-	3	195	07	July 9	By Sundries, as per Journal,	-	-	160	13	00		
July 9	1769	To Cash, for charges here,	-	-	1	97	12	10	By Sundries, as per Journal,	-	-	98	04	06		
									By Profit and Loss,	-	-	6	34	01		
														292	19	05
	41															
		William Boyd my acct-curt,							Contra,							
1769																
June 18	1769	To Voyage to Jamaica, balance in his hands,	-	-	3	108	19	July 15	By Edward Dupper, due at 10 days,	-	-	7	108	19	07	

( 7 ) L E D G E R .

L E D G E R . ( 7 )

N <sup>o</sup>		Dr	Cr	Fo	l.	s.	d.
1769 July 2	Charges of Merchandize,	Dr					
	To Cash, for $\frac{1}{2}$ year's shop-rent,	-	1	12	00	00	
	To Cash, paid postage, &c.	-	1	2	12	08	
					14	12	08
1769 July 9	John Dyer,	Dr		6	80	00	00
	To Voyage from Jamaica, due at 6 Mo.						
1769 July 10	Pymiento,	Dr	lb.	6	38	07	06
	To Voy. from Jamaica, at 6d. for		1535	6	25	11	08
	To Profit and Loss, gained,				63	19	02
1769 July 10	Sugar,	Dr	C.	6	59	17	00
	To Voy. from Jamaica, at 19s. for		63				
1769 July 15	Edward Dupper,	Dr		6	108	19	07
	To Wil. Boyd, my acc. curt. at 10 days,						
1769 July 22	Voyage to Hamburg,	Dr		6	226	17	08
	To Sundries, as per Journal,	-		6	16	17	08 $\frac{1}{2}$
	To Profit and Loss, gained,	-			243	15	04 $\frac{1}{2}$
1769 Aug 10	Herman Van Beek his	} Dr		1	14	12	06
	account of goods,						
	To Cash, paid charges,		-	1	10	07	06
	To Cash, for storage, brokerage, &c.		-	6	12	05	00
	To Profit and Loss, for my commif. at 2 $\frac{1}{2}$ ,			7	54	00	00
	To H. Van Beek his account on time due by T. Freeman,		7	39	15	00	
	To ditto his account-current, in my hand:			474	00	00	
1769 Aug 23	Herman Van Beek his	} Dr		11	54	00	00
	account on time,						
	To Balance, outstanding,						
1769 Aug 30	Herman Van Beek his	} Dr		1	38	07	06
	account current,			8	200	00	00
	To Sundries, as per Journal		-	1	53	06	08
	To Bills payable, for 1 to W. Sabin, at 6 days		-	1	00	10	06
	To Cash, remitted him,						
	To Balance, due to him,						
				39	115	08	

	Cr	Dr	Fo	l.	s.	d.	
1769 July 2	Contra,	Cr					
	By Profit and Loss,	-	6	14	12	08	
1769 July 9	Contra,	Cr					
	By Balance due by him,	-	11	80	00	00	
1769 Aug 30	Contra,	Cr	lb.	7	63	19	02
	By H. V. Beek his account-current, at 10d.	-	1535				
1769 July 22	Contra,	Cr	C.	7	59	17	00
	By Voy. to Hamburg, at 19s. for		63				
1769 July 30	Contra,	Cr		11	108	19	07
	By Cash, received in full,	-					
1769 Sept. 22	Contra,	Cr		8	226	17	08
	By John Perkins my account current,						
	By Cash, for drawback on sugar,						
				243	15	04 $\frac{1}{2}$	
1769 Aug 17	Contra,	Cr		1	200	00	00
	By Cash, for 14 butts madder,	-					
	By Tho. Freeman, for 18 C. flax, due at months,	-	2	54	00	00	
1769 Aug 23	Contra,	Cr		7	54	00	00
	By H. V. Beek his account of goods, due by T. Freeman,	-					
1769 Aug 23	Contra,	Cr		7	53	06	08
	By H. Van Beek his account of goods,						
	By James Wright, abated,		8	00	10	06	

No.		L. s. d.		L. s. d.		L. s. d.	
1769	51	James Wright, Dr		1769	Contra, Cr		
Aug. 31		To Sundries, as per Journal, -	01208	Aug. 30	By H. V. Beek his acct-cur. for coo- perage, -	01208	
1769	52	Bills payable, Dr		1765	Contra, Cr		
Sept. 10		To Cash, paid Wil. Sabin Van Beck's bill, -	2000000	Sept. 3	By H. V. Beek his acc-cur. for 1 at 6 days, -	2000000	
1769	53	John Perkins my } Dr Flemish. l. s. d.		1769	Contra, Cr Flemish. l. s. d.		
Sept. 22		To Voy. tollamb. at 34s. 5d. } 405 5 1 1/2	235 10 00	Sept. 30	By Bills receivable, exch. } at 34s. for - - - } 405 5 0 1/2	238 07 08 1/2	
		To Profit and Loss - - - - -	217 08 1/2				
			238 07 08 1/2				
1769	54	Edward Hopkins my ac- } Dr		1769	Contra, Cr		
Oct. 4		To Cash, paid 1/2 share of 10 hhd's tobacco, -	6000000	Oct. 9	By Sundries, as per Journal, -	720704	
		To Cambrics, for my 1/2 share of 40 ps. at 3l. -	6000000	20	By Sundries, as per Journal, -	620800	
		To Profit and Loss, gained, -	041504			1341504	
			1341504				
1769	55	Edward Hopkins my ac- } De		1769	Contra, Cr		
Oct. 9		To Cambrics, for his 1/2 share of 40 ps. at 3l. -	6000000	Oct. 11	By Cash, received in full, - - -	6000000	
1769	56	Stuffs, Dr Pieces.		1759	Contra, Cr Pieces.		
Oct. 21		To James Ward, at 2l. 8s. for 90 -	2160000	Nov. 15	By Voyage to Lisbon in com- } pany, at 2l. 10s. for } 90	2250000	
		To Profit and Loss, gained, -	900000				
			2250000				
1769	57	James Ward, Dr		1759	Contra, Cr		
		To Balance due to him, -	2160000	Oct. 21	By Stuffs, to pay at 3 months, -	2160000	
1769	58	Ship Phoenix in company } Dr		1769	Contra, Cr		
Oct. 22		To Sundries, as per Journal, -	6400000	Oct. 25	By Cash for 1 month's freight, -	220000	
		To Cash, paid repairs - - - - -	161000	Dec. 27	By Cash, for 1 month's freight, -	220000	
		To Cash, paid premium on 600l. -	180000	28	By Mr Jones and company, sold -	700000	
		To G. Kent his acct in Co. for his 1/2 gained, -	341500			744000	
		To Profit and Loss, for my half gained, -	341500				
			744000				
1769		George Kent his account } Dr		1769	Contra, Cr		
Oct. 25		To ditto his account proper for his 1/2 of 1 month's freight, -	110000	Oct. 22	By Ship Phoenix in Co. for his 1/2 share, -	320000	
Nov. 29		To ditto his account-proper, for 1/2 of 5 pipes of sherry, -	721000	25	By ditto his acct proper, for half repairs, -	80500	
Dec. 1		To ditto his acct prop. for 1/2 of 4 pip. sherry -	550100		By ditto his acct prop. for his 1/2 of prem. -	90000	
Nov. 27		To ditto his acct prop. for 1/2 of freight, -	110000	26	By ditto his acct proper, for his half of 9 pipes sherry, -	1150500	
Dec. 28		To ditto his account-proper for 1/2 of Phoenix, sold, -	350000	Nov. 1	By ditto his acct proper, for his half carriage, &c. -	11100	
			4991400		By ditto his acct prop. for his 1/2 of commif. -	31403	
					By Sh. Phoenix in Co. for his 1/2 share gained, -	341500	
					By Sherry in comp. for his half gained, -	40309	
						4991400	

( 9 ) L E D G E R .

L E D G E R . ( - 9 )

No.		Dr	Cr	l.	s.	d.
60	<i>George Kent his acct prop.</i>	Dr				
1769						
Oct. 25	To dit. his acct in com. for hi half repairs,		8	8	05	00
	To dit. his ac. in com. for his half premium,		8	9	00	00
26	To dit. his ac. in com. for $\frac{1}{2}$ of 9 pipes sherry,		8	118	05	00
Nov. 1	To dit. his acct in comp. for $\frac{1}{2}$ carriage,		8	1	11	00
	To dit. his acct in comp. for his $\frac{1}{2}$ of com.		8	3	14	03
4	To Cash paid him,		9	122	08	09
	To Balance, due to him,		11	361	00	00
				624	04	00
61	<i>Cash,</i>	Dr				
1769						
Oct. 25	To old account,		1	9698	00	03 $\frac{1}{2}$
27	To <i>George Kent his account proper,</i>		9	124	10	00
29	To <i>Sherry in co.</i> in part for 5 pipes, at 29 l.		9	120	00	00
1	To <i>Sherry in com.</i> for 4 pipes, at 27 l. 12 s.		9	110	08	00
	To <i>Ed. Turner,</i> in full for sherry,		9	25	00	00
8	To <i>Sundries,</i> as per Journal,			405	00	00
12	To <i>George Evans,</i> received in composition,		2	180	00	00
	To <i>N. Napier,</i> in full for druggets,		6	62	00	00
25	To <i>S. King his acct prop.</i> received of him,		10	34	00	00
Dec. 2	To <i>Oil in co.</i> in part for 7 tuns, at 30 l. 10 s.		10	113	10	00
13	To <i>George Young,</i> in full,		4	100	00	00
18	To <i>Canary in co.</i> for 6 pipes, at 29 l. 12 s.		11	177	12	00
20	To <i>J. Fuller,</i> rec <sup>d</sup> in compos <sup>n</sup> of his debt,		10	12	00	00
27	To <i>Ship Phoenix in co.</i> for 1 M <sup>o</sup> freight,		8	22	00	00
				1184	00	03 $\frac{1}{2}$
52	<i>Sherry in company with</i>	Dr				
	<i>George Kent.</i>					
1769						
Oct. 26	To <i>Richard Owen,</i> at 26 l. for	Pipes	4	104	00	00
	at 26 l. 10 s. for			132	10	00
Nov. 1	To <i>Cash,</i> paid carriage, &c.		9	3	02	00
	To <i>Profit and Loss,</i> for my			6	7	08
	commis. at $\frac{1}{2}$ per cent:			8	4	03
	To <i>Geo. Kent his account in</i>			6	4	03
	<i>company</i> for his $\frac{1}{2}$ gained,					
	To <i>Profit and Loss,</i> for my					
	half gained,					
			9	255	08	00
53	<i>Richard Owen,</i>	Dr				
1769						
Oct. 27	To <i>Cash,</i> paid him in full,		9	236	10	00
54	<i>Edward Turner,</i>	Dr				
1769						
Oct. 29	To <i>Sherry on company,</i> on demand,		9	25	00	00
55	<i>House-expences,</i>	Dr				
1769						
Nov. 11	To <i>Cash,</i> paid 1 year's rent of my dwelling-house,		9	40	00	00
Dec. 30	To <i>Cash,</i> laid out since the 1st of Jan. last,		9	200	00	00
				240	00	00
66	<i>Voyage to Lisbon in com. with</i>	Dr				
	<i>Simon King and John Oker,</i>					
1769						
Nov. 15	To <i>Sundries</i> as per Journal,			995	00	00

No.		Cr	Dr	l.	s.	d.
1769	<i>Contra,</i>	Cr				
Oct. 25	By dit. his acct. in comp. for his $\frac{1}{2}$ freight,		8	11	00	00
27	By <i>Cash,</i> for his half of disbursements and sherry,		9	124	10	00
29	By dit. his acct in co. for $\frac{1}{2}$ of 5 pipes sherry.		8	72	10	00
Dec. 1	By dit. his acct in co. for $\frac{1}{2}$ of 4 pipes sherry,		8	55	04	00
27	By ditto his acct in comp. for $\frac{1}{2}$ of freight,		8	11	00	00
28	By dit. his acct in co. for $\frac{1}{2}$ of <i>Phoenix</i> sold.		8	350	00	00
				624	04	00
1769	<i>Contra,</i>	Cr				
Oct. 25	By <i>Ship Phoenix in company,</i> for premium		8	18	00	00
27	By <i>Richard Owen,</i> in full for sherry,		9	236	10	00
Nov. 1	By <i>Sherry in company,</i> paid carriage, &c.		9	3	2	00
4	By <i>Geo. Kent his account proper,</i> paid him,		9	122	08	09
11	By <i>House-expences,</i> paid one year's rent,		9	40	00	00
15	By <i>Voyage to Lisbon in company,</i>		9	50	00	00
17	By <i>Simon King his account proper,</i>		9	56	13	04
25	By <i>George Wood,</i> paid him,		10	211	00	00
Dec. 30	By <i>House-expences,</i> since the 1st Jan. last		9	200	00	00
	By <i>Balance,</i> remaining in my hands,		11	102	46	60 $\frac{1}{2}$
				1184	00	03 $\frac{1}{2}$
1769	<i>Contra,</i>	Cr				
Oct. 29	By <i>Sundries,</i> at 29 l. for	Pipes.	5	145	00	00
1	By <i>Cash,</i> at 27 l. 12 s. for		4	110	08	00
			9	255	08	00
1769	<i>Contra,</i>	Cr				
Oct. 26	By <i>Sherry in company,</i> on demand,		9	236	10	00
1769	<i>Contra,</i>	Cr				
Nov. 1	By <i>Cash,</i> received in full,		9	25	00	00
1769	<i>Contra,</i>	Cr				
By <i>Profit and Loss,</i>				240	00	00
1769	<i>Contra,</i>	Cr				
By <i>Sim. King his acct in comp.</i> $\frac{1}{2}$ remaining			10	331	13	04
By <i>J. Oker his acct in comp.</i> $\frac{1}{2}$ remaining,			10	33	13	04
By <i>Balance,</i> for my $\frac{1}{2}$ remaining,			11	331	13	04
				995	00	00

		Fol. l. s. d.		
<b>67</b>				
Simon King, his acct prop. Dr				
1769				
Nov. 15	To ditto his accompt in comp. for his $\frac{1}{3}$ of voyage to Lisbon,	10	331	13 04
17	To Sundries, as per Journal,	-	108	06 08
22	To dit. his ac. in co. for his $\frac{1}{3}$ of 18 tuns oil,	10	177	00 00
Dec. 20	To dit. his ac. in co. for his $\frac{1}{3}$ of 18l. abated,	10	6	00 00
	To Balance, due to him,	11	134	07 04
			757	07 04
<b>68</b>				
John Oker his accompt-proper, Dr				
1769				
Nov. 15	To ditto his accompt in comp. for his $\frac{1}{3}$ of voyage to Lisbon,	10	331	13 04
22	To dit. his ac. in co. for his $\frac{1}{3}$ of 18 tuns oil,	10	177	00 00
25	To Simon King his acct-prop. paid to him,	10	23	00 00
Dec. 20	To dit. his ac. in co. for his $\frac{1}{3}$ of 18l. abated,	10	6	00 00
	To Balance, due to him,	11	134	07 04
			672	00 08
<b>69</b>				
Simon King his acct in co. Dr				
1769				
Nov. 30	To dit. his ac. pr. for his $\frac{1}{3}$ of 1 tun oil fold,	10	10	00 00
Dec. 2	To dit. his ac. pr. for his $\frac{1}{3}$ of 7 tuns oil fold,	10	71	03 04
18	To ditto his accompt-proper, for his $\frac{1}{3}$ of 6 pipes canary fold,	10	59	04 00
24	To Canary in co. for 2 pipes taken to himself,	11	50	00 00
	To Voy. to Lisbon in co. for his $\frac{1}{2}$ remaining,	9	331	13 04
			522	00 08
<b>70</b>				
John Oker his acct in comp. Dr				
1769				
Nov. 30	To dit. his ac. pr. for his $\frac{1}{3}$ of 1 tun oil fold,	10	10	00 00
Dec. 2	To dit. his ac. pr. for his $\frac{1}{3}$ of 7 tuns oil fold,	10	71	03 04
18	To ditto his accompt-proper, for his $\frac{1}{3}$ of 6 pipes canary fold,	10	59	04 00
24	To Canary in co. for 2 pipes taken to himself,	11	50	00 00
	To Voy. to Lisbon in co. for his $\frac{1}{2}$ remaining,	9	331	13 04
			522	00 08
<b>71</b>				
Oil in co. with Simon } King and J. Oker, } Dr				
1769				
Nov. 22	To George Wood, at 29l. 10s. for	18	10	531 00 00
Dec. 20	To James Fuller, abated him,	-	10	18 00 00
	To S. K. his ac. in co. for his $\frac{1}{3}$ gained	-	10	4 16 08
	To J. O. his ac. in co. for his $\frac{1}{3}$ gained	-	10	4 16 08
	To Profit and Loss, for my $\frac{1}{3}$ gained,	-	6	4 16 08
			565	10 00
<b>72</b>				
George Wood, Dr				
1769				
Nov. 25	To Sundries, as per Journal,	-	531	00 00
<b>73</b>				
James Fuller, Dr				
1769				
Nov. 30	To Oil in company, to pay at 14 days,	10	30	00 00

		Fol. l. s. d.		
<b>1769</b>				
Contra, Cr				
1769				
Nov. 15	By Voy. to Lisbon in co. for 80 pieces serge,	9	440	00 00
25	By George Wood, paid to him,	10	120	00 00
	By Sundries, as per Journal,	-	57	00 00
	By dit. his ac. in co. for his $\frac{1}{3}$ of 1 tun oil fold,	10	10	00 00
Dec. 2	By dit. his ac. in co. for his $\frac{1}{3}$ of 7 tuns oil fold,	10	71	03 04
18	By ditto his accompt in company, for his $\frac{1}{3}$ of 6 pipes canary fold,	10	59	04 00
			757	07 04
<b>1769</b>				
Contra, Cr				
1769				
Nov. 15	By Voy. to Lisbon in co. for 70 pieces frieze,	9	280	00 00
17	By S. King his accompt-proper,	10	51	13 04
25	By George Wood, paid to him,	10	200	00 00
30	By dit. his ac. in co. for his $\frac{1}{3}$ of 1 tun oil fold,	10	10	00 00
Dec. 2	By dit. his ac. in co. for his $\frac{1}{3}$ of 7 tuns oil fold,	10	71	03 04
18	By ditto his accompt in comp. for his $\frac{1}{3}$ of 6 pipes canary fold,	10	59	04 00
			672	00 08
<b>1769</b>				
Contra, Cr				
1769				
Nov. 15	By dit. his ac. pr. for his $\frac{1}{3}$ of voy. to Lisbon,	10	331	13 04
22	By ditto his acct prop. for his $\frac{1}{3}$ of 18 tuns oil bought,	10	177	00 00
Dec. 20	By dit. his ac. prop. for his $\frac{1}{3}$ of 18l. abated,	10	6	00 00
	By Oil in company, for his $\frac{1}{3}$ gained,	10	4	16 08
	By Canary in company, for his $\frac{1}{3}$ gained,	10	2	10 08
			522	00 08
<b>1769</b>				
Contra, Cr				
1769				
Nov. 15	By dit. his ac. pr. for his $\frac{1}{3}$ of voy. to Lisbon,	10	331	13 04
22	By ditto his acct prop. for his $\frac{1}{3}$ of 18 tuns oil bought,	10	177	00 00
Dec. 20	By dit. his ac. prop. for his $\frac{1}{3}$ of 18l. abated,	10	6	00 00
	By Oil in company, for his $\frac{1}{3}$ gained,	10	4	16 08
	By Canary in comp. for his $\frac{1}{3}$ gained,	11	2	10 08
			522	00 08
<b>1769</b>				
Contra, Cr				
1769				
Nov. 30	By James Fuller,	1	10	30 00 00
Dec. 2	By Sundries, as per Journal,	7	21	3 10 00
7	By Canary in co. in barter at 32l. for	10	11	32 00 00
			18	563 10 00
<b>1769</b>				
Contra, Cr				
1769				
Nov. 22	By Oil in company, on demand,	10	531	00 00
<b>1769</b>				
Contra, Cr				
1769				
Dec. 20	By Sundries, as per Journal,	-	6	30 00 00



# B O O K - K E E P I N G .

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## ( 11 ) L E D G E R

## L E D G E R . ( 11 )

N <sup>o</sup>		Fo	l.	s.	d.
74	Canary in co. with S. } King and J. Oker, } Dr				
1769 Dec. 7	To Oil in company, in barter	12	10	320	00 00
	To S. King his acct in co. for his $\frac{1}{4}$ gained,		10	2	10 08
	To J. Oker his acct in comp. for his $\frac{1}{4}$ gained,		10	2	10 08
	To Profit and Loss, for my $\frac{1}{4}$ gained,		6	2	10 08
					327 12 00
75	Canary, Dr				
1769 Dec. 24	To Canary in co. retained at 25l.	2	11	50	00 00
75	Mr Jones and Company, Dr				
1769 Dec. 28	To Ship Phoenix in co. to pay at 3 M <sup>o</sup> ,	8		700	00 00
77	Balance, Dr				
	To Cash, remaining in my hands,	9	10	246	06 02 $\frac{1}{2}$
	To Indian Chints, remaining 5 pieces, at 24l. 10s.	1		122	10 00
	To Ship Britannia, for $\frac{1}{4}$ remaining,	1		348	10 00
	To Tho. Freeman, due for V. Beek's flax,	2		54	00 00
	To Duroys, rem. 30 pieces, at 26s.	2		39	00 00
	To John Vernon, due by him,	3		200	00 00
	To Fustians, rem. 120 pieces, at 37s. 6d.	3		225	00 00
	To Jacob Spencer, lent him,	4		1000	00 00
	To Bills receivable, as per accompt,	4		383	07 08 $\frac{1}{2}$
	To Lockrams, rem. 40 pieces, at 25s.	4		50	00 00
	To Cochineal, remaining 1 C.	4		108	16 00
	To Cinnamon, rem. 64 lb. at 7s. 8d.	4		24	10 08
	To Muslin, rem. 8 bales, at 12l. 16s.	5		102	08 00
	To Cotton, rem. 42 C. 2 Q. at 3l. 15s.	5		159	07 06
	To Cloves, remaining 12 lb. at 9s. 1d. and 72 lb. at 9s.	5		37	17 00
	To John Jessop, his ac. curt, due by him,	5		160	15 00
	To John Dyer, due by him,	7		80	00 00
	To Voy. to Lisbon in co. for my $\frac{1}{4}$ rem.	9		33	11 30 4
	To Canary, remaining 2 pipes, at 25l.	11		50	00 00
	To Mr Jones and Company, outstanding,	11		700	00 00
					14424 01 05

N <sup>o</sup>		Fo	l.	s.	d.
	Contra, Cr				
1769 Dec. 18	By Cash, at 29l. 12s. for	6	9	177	12 00
24	By Sundries, at 25l. for	6		150	00 00
		12		327	12 00
	Contra, Cr				
	By Balance, remaining at 25l.	2	11	50	00 00
	Contra, Cr				
	By Balance, outstanding,		11	700	00 00
	Contra, Cr				
	By Jacob Ruffel, due to him,	3		49	10 00
	By H. Van Beek, his acct on time,	7		54	00 00
	By H. Van Beek, his acct-current,	7		0	01 06
	By James Ward, due to him,	8		216	00 00
	By George Kent his acct-proper,	9		361	00 00
	By Simon King his acct-proper,	10		134	07 04
	By John Oker his acct-proper,	10		134	07 04
	By Stack, the neat of my estate,	2	13	474	15 03
					14424 01 05

Of the SUBSIDIARY BOOKS used by MERCHANTS.

THOUGH all merchant-accounts may be kept by the *Waste-book*, *Journal*, and *Ledger*, alone; yet men of great business find it convenient, either for abridging these, or for other ends, to use some others, generally called *subsidiary* or *subservient Books*; the most common of which are these nine following, viz.

1. *The Cash-book.*

THIS book is kept in a folio form, like the Ledger, and serves to abridge the Cash-account there. On the left-hand page, or Dr side, *Cash* is charged Dr for all the sums received; and on the right-hand page, *Cash* is made Cr for all the sums paid. Once a week, or, which is more ordinary, once a month, this book is posted to the Ledger; or, if you please, first to the Journal, by two entries, viz. *Cash* Dr to *Sundries*, for all the receipts, and *Sundries* Drs to *Cash*, for all the payments. By this means the Cash-account in the Ledger will be so far contracted as to consist of 12 lines, viz. one for each month in the year. A specimen of this book follows.

1769.		l.	s.	d.
July	<i>Cash, Dr.</i>			
1	To George Hill, received in full for lead,	90	00	00
5	To John Scot, in part for sugar,	100	10	00
12	To Robert Hunter, for A. B's bill on him,	30	00	00
18	To Port wine, received for 1 pipe,	20	10	00
31	To James Neil and comp. in full for tobacco,	100	00	00
		356	00	00

1769.		l.	s.	d.
July	<i>Contra, Cr.</i>			
3	By George Duncan, paid in full for canary,	100	00	00
11	By R. Richmond and Co. in part for dowlas,	60	00	00
20	By Samuel Smith, paid him R. Blair's bill,	100	00	00
25	By Holland, for 2 pieces, at 18l.	30	00	00
31	By Charges of merchandize,	56	20	2
	By House-expences,	36	00	00
		298	02	02

Note, Merchants that have cash-keepers must beware to write any thing in the Cash-book themselves; for if they do, the cash-keeper is no more accountable for what is stated in the book; and therefore the master, in case of money delivered to him, in the cash-keeper's absence, must keep it till he come home; and then deliver it to him, and see him enter it in the book himself.

2. *The Book of Charges of Merchandize.*

THIS book is only paged, and designed to abbreviate the Cash-book. It contains particular charges on goods and voyages; such as, carriage, custom, freight, crantage, wharfage, &c.: As also other expences that affect trade in general; such as, warehouse-rent, shop-rent, accountant's wages, postage of letters, and the like. At the end of each month

the money-columns of this book are added up, and the sum carried to the credit-side of the Cash-book.

N. B. At the same time you post the monthly sums of this book to the Cash book, you must debit the several accounts of goods and voyages for their particular shares of charges; which is done by passing the following entry in the Journal, namely, *Sundries* (viz. the several accounts of goods and voyages for their respective shares) Drs to *Charges of merchandize*. The remaining part of these charges will be such as relate to trade in general, being chargeable to no particular account, and will of course fall into the general account of *Profit and Loss*, when the account of *Charges of merchandize* in the Ledger is closed, at balancing the books. The form of this book follows,

1769.		l.	s.	d.
July	<i>Charges of Merchandize, Dr.</i>			
1	To Cash, paid for freight of 10 tuns of iron,	18	00	00
3	To ditto, paid custom of ditto,	20	15	02
8	To ditto, paid other petty charges on ditto,	0	18	00
12	To ditto, paid portorage of goods bought of A. B.	0	2	06
	To ditto, paid the stationers for paper,	2	14	00
18	To ditto, paid postage of letters,	0	10	06
27	To ditto, paid rent of 2 cellars,	3	18	00
31	To ditto, paid charges on 12 bales of skins,	90	00	
		56	02	02

*The Book of House-expences.*

THIS book is also paged, and designed likewise to ease the Cash-book. It contains all disbursements for family-provisions, servants wages, house-rent, apparel, utensils, &c. The money-columns of this book are also added up at the end of each month, and the sum transferred to the credit side of the Cash-book.

N. B. If goods are brought from the shop for the use of the family, this more properly belongs to the Waste book, and is not to be inserted here. A specimen of this book follows.

1769.		l.	s.	d.
July	<i>House-expences, Dr.</i>			
1	To Cash, paid for new cloaths, hat, and shoes,	10	00	06
10	To ditto, paid for six drinking-glasses,	0	00	04
17	To ditto, paid for earthen-ware,	0	03	00
25	To ditto, paid for 12 dozen bottles,	1	00	00
31	To ditto, paid pocket-expences,	9	00	00
	To ditto, paid the housekeeper,	15	06	09
		36	00	00

4. *The Invoice-book.*

THIS book, which is used chiefly by factors, is paged, and contains doubles or copies of the invoices of goods sent to sea, or of goods received from abroad. The form of an invoice is as follows.

London,

London, 1st July 1769.

Invoice of 8 boxes indigo, and 4 boxes spiceries, shipped per the Bonadventure, Robert Hay master, for Leith, by order, and for account of A. B. merchant there.

A. B. INDIGO 8 boxes.		l. s. d.	
Gross. Tare.			
N <sup>o</sup> 1—70 <sup>1</sup>	: 14 <sup>1</sup> / <sub>2</sub>		
2—65	: 13 <sup>1</sup> / <sub>2</sub>		
3—80	: 15		
4—67	: 13		
5—75	: 24		
6—57 <sup>1</sup> / <sub>2</sub>	: 12 <sup>1</sup> / <sub>2</sub>		
7—64	: 13 <sup>1</sup> / <sub>2</sub>		
8—85 <sup>1</sup> / <sub>2</sub>	: 16		
<hr/>			
564 <sup>1</sup> / <sub>2</sub>	111 <sup>1</sup> / <sub>2</sub>		
111 <sup>1</sup> / <sub>2</sub>			
<hr/>			
452 <sup>1</sup> / <sub>2</sub> lb. neat, at 4s. 3d.		96	4 2 <sup>1</sup> / <sub>2</sub>
Boxes, - - - - -		0	9 4
<hr/>		96	13 06 <sup>1</sup> / <sub>2</sub>
SPICERIES 4 boxes.		l. s. d.	
lb.			
N <sup>o</sup> 1—12 cinnamon, at 7s. 9d.		4	13 0
2—4 nutmegs, at 8s. 8d.		1	14 8
3—57 pymento, at 8d.		0	15 6
4—1 mace, - - - - -		0	15 6
Boxes, - - - - -		0	4 6
<hr/>			
		9	05 08
Bill of lading, cocket, and other charges,		0	05 09
<hr/>			
		106	08 11 <sup>1</sup> / <sub>2</sub>
Commission at 2 <sup>1</sup> / <sub>2</sub> per cent.		2	11 00
Insurance on the above 100l. 1 <sup>1</sup> / <sub>2</sub> per cent. and policy, 4s. 6d. is		1	12 06
Commission on ditto at <sup>1</sup> / <sub>2</sub> per cent.		0	10 00
<hr/>			
		111	06 05 <sup>1</sup> / <sub>2</sub>

Errors excepted, per M. S.

N. B. When a merchant in Britain ships off imported goods, such as tobacco, to Holland, or other places, for sale, the invoice sent to the factor usually contains only the marks, numbers, and quantity shipped, but nothing of the prime cost or charges; which in this case could not be easily ascertained; and the want thereof is pretty well supplied by intrusting the factor not to sell under such a price. But invoices of all kinds of manufactures and goods consigned from Britain to North America or the West Indies, generally exhibit prime cost and all charges; which is necessary, not only as it serves for a sort of directory to the factor, but still more so, in regard British goods are frequently sold in those places at so much advance on the invoice prices.

5. The Sales-book.

This book too is chiefly used by factors; and into it is posted, from the Waste-book, the particular sales of every consigned cargo; by which means the several articles of a sale, that lie scattered in the Waste-book, are brought together, and represented under one view; and that in a manner more full and minute than they are collected in the Ledger account. This book exhibits the sales of every consignment separately and by themselves; to which are subjoined the respective charges, such as freight, custom, the factor's commission, as

also abatements allowed to buyers, &c. whose sum subtracted from the gross amount of sales, gives the neat proceeds. From this book, when a cargo is sold off, an account of sales is drawn out, in order to be transmitted to the employer, If the consignment consist but of one kind of goods, the Sales-book may be ruled and written up as in the following example.

Rotterdam, 1st June 1765.

Sales of 6 packs serges, containing 4380 yards, received per the Friendship, Samuel Sharp master, for account of A. B. merchant in Glasgow, North Britain.

1769		Guil. St. D.	
June 2			
Sold Frederick Gordon, at 1 month,			
Packs. Pieces. Yards.			
N <sup>o</sup> 1—19	—743		
4—20	—643		
<hr/>			
		1386	at 7 stivers.
		48	02 00
28	Sold for ready money,		
N <sup>o</sup> 2—17	—717		
3—18	—730		
5—14	—830		
6—16	—717		
<hr/>			
		2994	at 6 stivers
		898	04 00
<hr/>			
Total 4380		1383	06 00
C H A R G E S .			
		G. St. D.	
Freight and average,		25	10 00
Custom and waiters dues,		31	00 00
Scout-freight, and other small charges,		3	00 00
Measuring, at 4 stivers per 100 yards,		8	14 00
Charges in selling, and pack-house-rent,		4	04 00
Commission, at 2 per cent.		27	13 00
<hr/>			
		100	01 00
Neat proceeds, (errors and bad debts excepted,) carried to the credit of his Account-current,		1283	05 00

If the consigned cargo consists of two or more kinds of goods, the Sales book must be ruled with columns for the different sorts of goods; and the heads of these columns must be titled with the names and quantities of the goods from the invoice.

6. The Bill-book.

The design of this Bill-book, or Month-book, is to furnish a merchant with a ready way of knowing the time when bills or other debts become payable to or by him. It consists of 12 folios, one for each month in the year. The left-hand page contains the debts that fall due to the merchant in the month on the top, and the right-hand page contains the debts payable by him to others in the same month; as in the annexed specimen.

1769.		l. s. d.	
Days			
January, to receive.			
1	Of Edward Finch, 600 crowns, at 54d. bill,	135	00 00
10	Of Robert Banks, for lintseed, -	86	10 00
23	Of George Hally, for Norwich stuffs,	35	00 00
31	Of John Short, 2539 guilders, 19 stivers, } at 34s. 5d. Flemish per L. Sterling,	246	00 00

		l.	s.	d.
1769.				
Days	January, to pay.			
3	To <i>Simon Smith</i> , 3000 crowns, at 56 d. } bill of <i>G. F.</i>	70	00	00
12	To <i>James Jeffery</i> , for sundry goods,	68	13	04
25	To <i>James Martin</i> and company,	125	00	00
30	To <i>James Halley</i> , for oil,	76	09	10

*N. B.* Upon the payment of any sum, merchants either cancel the line, or, which is better, they write the word *Received* or *Paid* upon the margin, or use some mark of their own, to signify that the sum to which it is affixed is paid.

### 7. The Receipt-book.

In this book a merchant takes receipts of the payments he makes. The receipt should contain the date; the sum received, expressed in words at large, and also in figures in the money-columns; the reason why; and whether in full or in part; and must be signed by the person receiving. But there is no occasion to mention the merchant's name; for the book being his own, sufficiently implies that. This book is paged, and the form of it is as follows.

		l.	s.	d.
Received, July 1. 1769, in part for sugar, } the sum of one hundred thirty six pounds,	per <i>John Stewart</i> .	136	00	00
Received, this 4th of July 1769, in full for } indigo, the sum of forty eight pounds ten } shillings,	per <i>Tho. Green</i> .	48	10	00
Received, July 6. 1769, in part for lead, } twenty pounds, for my master <i>David Douglas</i> ,	per <i>Sam. Sprat</i> .	20	00	00
Received, July 10. 1769, in full for co- } peras, thirty six pounds twelve shillings, for } self and company,	Per <i>David Duff</i> .	36	12	00
Received, July 11. 1769, forty-five pounds } twelve shillings and nine pence, in full for to- } bacco sold the 10th of January last, for self } and partner,	Per <i>Simon Truhy</i> .	45	12	09
Received, July 12. 1769, the sum of fifty } pounds, by order, and for the account of } <i>George Grant</i> ,	Per <i>Nath. Smith</i> .	50	00	00

### 8. The Copy-Book of Letters.

It is very imprudent in any person to send away a letter of business, without keeping a double of it to himself; and there-

fore, to prevent the bad consequences of such a careless practice, merchants are provided with a large book, in *folio*, into which is copied *verbatim* every letter of business before it be sent off. So that this book, together with the letters received (which must also be carefully kept in files or boxes,) makes a complete history of all the dealings that pass betwixt a merchant and his correspondents; which may be very useful and necessary on many occasions.

### 9. The Pocket-book.

This is a small book, of a portable size, which a merchant carries in his pocket when business calls him abroad to a tavern, a fair, the country, or other places. In this he sets down the bargains he makes, the expences he is at, the debts he pays, or sums he receives, with every other part of business he transacts while abroad; as also any occurrence or piece of news he thinks worth while to record. And when he comes home to his counting-house or shop, he transfers the things contained in this book, each to their proper places in the Waste-book, or Books Subsidiary.

Factors of great business sometimes keep another small book, called the *Memorandum book*. Into this book is copied, from letters as they come to hand, short notes of the several commissions for buying goods contained in them; and as the commissions are effected, the notes are crossed, or have some mark affixed to them. This is more convenient in doing business, than to be continually running to the letters themselves. Suppose a merchant of Lisbon, by his letter, give a commission for buying goods, a note of it in the *Memorandum book* will stand thus.

Lisbon, 15th June 1769.

Out of *Carlos Popham's* letter an order for  
4000 yards of serges, at 8 d. or 8½ d. per yard,  
20 dozen stockings, not above 36 s. per dozen, &c.

All which to be packed and shipped for Lisbon, con-  
signed to himself, and marked *C. P.*

In like manner factors may, and those much employed generally do, take a note, from the letters of advice, of all the goods consigned to them, either in a separate place of this book, or in another book of the same nature. By this means a factor has daily under his eye, both the time when such a ship may be expected, and the goods she brings: And so is a readier way of minding to look out for a merchant for them before-hand, than if he had only the letter as his remembrancer. An example follows.

Naples, 18th June 1769.

In the *Prosperity*, *Robert Wilson* master, silks for ac-  
count of *Anthony Carew*, marked *A. C. N° 122 to 140.*

The above are the subsidiary books most in use: But a merchant is not tied down or restricted to them; he may keep some, and neglect others, or invent more, as the nature of his business requires, and he finds convenient.

*Addendum*

*Addendum to the article B o o k.*

All foreign bound books pay duty on importation 14s. for every 112 lb. As to unbound books, they are commonly entered by the hundred weight, and pay, if French, 13 s. 6 $\frac{4}{8}$  d. but if from any other country, only 7s. 7 $\frac{2}{8}$  d. It is also to be observed, that all popish books are prohibited to be imported; as are all English books printed abroad, unless with the consent of the proprietor of the copy.

*Common-place-Book.* See *COMMON-place-book.*

*Text-Book.* See *TEXT.*

*Book-binding.* The art of gathering and sewing together the sheets of a book, and covering it with a back, &c. It is performed thus: The leaves are first folded with a folding-stick, and laid over each other in the order of the signature; then beaten on a stone with a hammer, to make them smooth and open well, and afterwards pressed. They are sewed upon bands, which are pieces of cord or packthread; six bands to a folio book, five to a quarto, octavo, &c. which is done by drawing a thread through the middle of each sheet, and giving it a turn round each band, beginning with the first, and proceeding to the last. After this the books are glued, and the bands opened and scraped, for the better fixing the pasteboards; the back is turned with a hammer, and the book fixed in a press between two boards, in order to make a groove for fixing the pasteboards; these being applied, holes are made for fixing them to the book, which is pressed a third time. Then the book is at last put to the cutting-press, betwixt two boards, the one lying even with the press, for the knife to run upon, the other above it, for the knife to run against: After which the paste-boards are squared.

The next operation is the sprinkling the leaves of the book, which is done by dipping a brush into vermilion and sap-green, holding the brush in one hand, and spreading the hair with the other; by which motion the edges of the leaves are sprinkled in a regular manner, without any spots being bigger than the others.

Then remains the covers, which are either of calfskin, or of sheep-skin; these being moistened in water, are cut out to the size of the book, then smeared over with paste made of wheat flour, and afterwards stretched over the pasteboard on the outside, and doubled over the edges withinside; after having first taken off the four angles, and indented and platted the cover at the head-band: which done, the book is covered, and bound firmly between two bands, and then set to dry. Afterwards it is washed over with a little paste and water, and then sprinkled fine with a brush, unless it should be marbled; when the spots are to be made larger, by mixing the ink with vitriol. After this the book is glazed twice with the white of an egg beaten, and at last polished with a polishing-iron passed hot over the glazed cover.

*BOOKSELLER,* one who trades in books, whether he prints them himself, or gives them to be printed by others.

Bookfellers are in many places ranked among the members of universities, and entitled to the privilege of students, as at Tubingen, Salisburg, and Paris, where they have always been distinguished from the vulgar and mechanical traders, and exempted from divers taxes and impositions laid upon other companies.

The traffic of books was anciently very inconsiderable, in so much, that the book-merchants of England, France, and Spain, and other countries, were distinguished by the appellation of *stationers*, as having no shops, but only stalls and stands in the streets. During this state, the civil magistrates took little notice of the bookfellers, leaving the government of them to the universities, to whom they were supposed more immediate retainers; who accordingly gave them laws and regulations, fixed prices on their books, examined their correctness, and punished them at discretion.

But when, by the invention of printing, books and bookfellers began to multiply, it became a matter of more consequence, and the sovereigns took the direction of them into their own hands; giving them new statutes, appointing officers to fix prices, and granting licences, privileges, &c.

*BOOKING,* among merchants, the making an entry of any thing in a Journal. See *BOOK-KEEPING.*

*BOOM,* in the sea-language, a long piece of timber with which the clew of the studding-sail is spread out; and sometimes the boom is used to spread or boom out the clew of the mainmast.

*Boom-spars,* imported from the British plantations, are free; if from Ireland, Asia, or Africa, they pay 6s. 5d. the hundred; and if from elsewhere, 9s. 6 $\frac{1}{2}$ d.

*BOOM* denotes also a cable stretched athwart the mouth of a river or harbour; with yards, topmasts, battling or spars of wood lashed to it, to prevent an enemy's coming in.

*BOOMING,* among sailors, denotes the application of a boom to the sails.

A ship is said to come booming forwards, when she comes with all the sail she can make.

*BOOPHTHALMUS,* a kind of agat with large circles in it, bearing some resemblance to an ox's eye, from whence it has got this name.

*BOOPS,* in zoology, the trivial name of a species of balæna. See *BALÆNA.*

*BOOT,* a well known cover for the leg, made of leather.

*BOOT-trac,* or *BOOT-last,* an instrument used by shoemakers to widen the leg of a boot. It is a wooden cylinder slit into two parts, between which, when it is put into the boot, they drive by main force a wedge or quoin.

*BOOTES,* a constellation of the northern hemisphere, consisting of 23 stars, according to Ptolemy's catalogue, of 18 in Tycho's, of 34 in Bayer's, of 52 in Helvetius's, and of 54 in Mr Flamsteed's catalogue. See *ASTRONOMY,* p. 486.

*BOOTY,* whatever is taken from an enemy in time of war.

*BOPPART,* a town of the electorate of Triers, situated on the west shore of the Rhine, about eight miles south of Coblentz: E. long. 7° 10', N. lat. 50° 20'.

**BOQUEROON**, an island in the E. Indian ocean, lying north-east of Borneo, in N. lat.  $3^{\circ}$ .

**BOQUINIANS**, in church-history, a sect of heretics, so called from Boquinus their founder, who taught that Christ did not die for all mankind, but only for the faithful, and consequently was only a particular Saviour.

**BORA**, in natural history, a name used by some for the Bufonites. See **BUFONITES**.

**BORAGO**, in botany, a synonyme of the anchusa. See **ANCHUSA**.

**BORAK**, a fabulous animal, said to be of a middle nature between an ass and a mule, and to have carried Mahomet in his aerial journeys from Jerusalem into heaven.

**BORASSUS**, in botany, a genus belonging to the order of palmæ stabellifoliæ. The borassus, of which there is but one species, has palmated and plaited leaves, and is a native of India.

**BORAX**, the name of a saline substance brought from the E. Indies in large masses, composed partly of large crystals, but chiefly of smaller ones, partly white and partly green, joined together, as it were, by a greasy yellow substance, intermingled with sand, small stones, and other impurities. The purer crystals, exposed to the fire, melt into a kind of glass, which is nevertheless soluble in water.

This salt, dissolved and crystalized, forms small transparent masses. The origin of this salt is not known; but experiments have clearly shewn, that it consists of a fixt alkaline salt, the same with the basis of sea-salt, in some degree neutralised by another saline substance, which is supposed to exist no where but in borax itself.

The medical virtues of borax are little known: In doses of half a dram to two scruples, it is supposed to be diuretic, emmenagogue, and a promoter of delivery.

**BORBONIA**, in botany, a genus of the diadelphia decandria class. The calix is pointed and prickly; and the stigma is emarginated. There are six species of borbonia, which is a kind of broom, all natives of America.

**BORBORITES**, in church-history, a sect of gnostics, in the second century, who, besides embracing the errors of these heretics, denied the last judgment.

Their name comes from the Greek, [*Borboret*], *silk*, on account of a custom they had of daubing their faces and bodies with dirt and silk.

**BORCH**, a town of lower Saxony, in Germany, about fourteen miles north-east of Magdeburg: E. long.  $12^{\circ} 14'$ , N. lat.  $52^{\circ} 25'$ .

**BORCHLEON**, or **LOOTS**, a town of the bishopric of Liege in Germany, about fifteen miles north-west of the city of Liege: E. long.  $5^{\circ} 30'$ , N. lat.  $50^{\circ} 50'$ .

**BORDAT**, in commerce, a small narrow stuff, which is manufactured in some parts of Egypt, particularly at Cairo, at Alexandria, and Damietta.

**BORDER**, in gardening, is made to inclose parterres, that they may not be injured by walking in them.

Borders are made either circular, strait, or in cants;

and are turned into knots, scrolls, volutes, and other compartiments. They are rendered very ornamental by the flowers, shrubs, yews, &c. that are raised in them. They are always laid with a sharp rising in the middle; because, if they are flat, they are no ways agreeable to the eye: And as for their breadth, the largest are allowed five or six feet, and the lesser commonly four. There are four sorts, 1. Those continued about parterres, without any interruption. 2. Those cut into compartiments and convenient distances by small passages; these two are raised in the middle, and adorned with flowers and shrubs. 3. Even and flat ones, without flowers. And, 4. Quite plain borders, only sanded, as in parterres of orangery.

**BORD-free**. See **FREE**.

**BORD-halfpenny**, a small toll, by custom paid to the lord of the town for setting up boards, tables, booths, &c. in fairs and markets.

**BORD-lands**, the demesnes which lords keep in their hands for the maintenance of their board or table.

**BORD-ade**, a service required of tenants to carry timber out of the woods of the lord to his house. It is also used to signify the quantity of provision which the bordarii or bordmen paid for their bord lands.

**BORD-service**, the tenure of bord-lands, by which some lands in certain places are held of the bishop of London, and the tenants now pay sixpence *per* acre, in lieu of finding provision anciently for their lord's table.

**BORDURE**, in heraldry, a cutting off from within the escutcheon all round it about  $\frac{1}{4}$  of the field, serving as a difference in a coat of arms, to distinguish families of the same name, or persons bearing the same coat. See Plate LI. fig. 16.

If the line constituting the bordure be strait and the bordure be plain, then in blazoning you must only name the colour of the bordure.

Bordures are sometimes ingrailed, gobonated, inverted, &c. See **INGRAILED**, &c.

If the border be charged with any part of plants or flowers, the term is verdoy of trefoils, or whatever flower it be. If it consist of ermins, vair, or any of the furs, they say purflew of ermins, &c. If the bordure be charged with martlets, the word is charged with an enalyron of martlets, &c.

Bordures are symbols of protection, favour and reward; and as such kings bestow them on those they have a value for.

**BORE**, among engineers, denotes the diameter of the barrel of a gun or cannon, or rather its whole cavity.

**Square BORE**, among mechanics, a square piece of well-tempered steel, fitted into a handle, serving to widen holes, and make them perfectly round.

**BOREAL**, in a general sense, something relating to the north. Thus,

**BOREAL signs**, in astronomy, are the first six signs of the zodiac, or those northwards of the equinoctial.

*Aurora BOREALIS*. See **PNEUMATICS**.

**BOREAS**, a Greek name, now in common use for the north wind.

Pezron observes, that anciently boreas signified the north-east wind, blowing at the time of the summer solstice.

**solstice.** Boreas is represented in painting like an old man with a horrible look, his hair and beard covered with snow or hoar frost, with the feet and tail of a serpent.

**BOREASMI**, in Grecian antiquity, a festival kept by the Athenians in honour of Boreas.

**BOREEL**, a cape on the north part of New Zeland, in the South Sea, lying west by south from the most southerly part of South America.

**BORGO**, a town of Finland, in the province of Nyland, upon the northern coast of the gulph of Finland.

**BORGO DI SESIA**, a town of Italy, in the dutchy of Milan, situated upon the Sesia.

**BORGO DE ST SEPULCHRO**, a town of Tuscany, about fifty miles east of Florence, near the head of the Tiber: E. long.  $13^{\circ}$ , and N. lat.  $43^{\circ} 30'$ .

**BORGO DE VAL DE FARO**, a town of Italy, in the dutchy of Parma, about twenty miles south-west of that city; E. long.  $10^{\circ} 36'$ , and N. lat.  $44^{\circ} 35'$ .

**BORGO-FORTE**, a town of the Mantuan, in Italy, situated at the confluence of the rivers Po and Menzo, about eight miles south of Mantua; E. long.  $11^{\circ}$  N. lat.  $44^{\circ} 50'$ .

**BORGO ST DOMINGO**, a city of Italy, in the dutchy of Parma, about ten miles north-west of that city; E. long.  $10^{\circ} 31'$ , N. lat.  $44^{\circ} 50'$ .

**BORIA**, a city of Arragon, in Spain, about thirty-five miles north-west of Saragossa; W. long.  $2^{\circ}$ , and N. lat.  $41^{\circ} 40'$ .

**BORING**, in a general sense, the art of perforating, or making a hole through any solid body.

**BORING of water-pipes.** The method of boring water-pipes is as follows. The poles of alder, which is a very useful wood in making pumps, water-pipes, &c. being laid on horses or tressels of a foot height, to rest the auger upon while they are boring, they set up a lath to turn the least end of the poles, to fit them to the cavities of the great end of the others. They turn the small ends of the poles about five or six inches in length, to the size they intend to bore the bigger ends about the same depth, viz. five or six inches. This is designed to make a joint to shut each pair of poles together, the concave part being the female part, and the other part the male of the joint. In turning the male part, they turn a channel in it, or a small groove at a certain distance from the end; and in the female part, they bore a small hole to fit over this channel. This being done, they bore the poles through; and to prevent them from boring out at the side, they stick great nails at each end to be a guide in boring. It is usual, however, to bore them at both ends; so that if a pole be crooked one way, they can bore it through, and not spoil it.

**BORING**, in farriery, an operation in use for the cure of wrenched shoulders in horses. It is this; having cut a hole in the skin, over the part affected, they blow it with up a tobacco-pipe, as a butcher does a shoulder of veal; after which they thrust a cold flat iron, like the point of a sword-blade, eight or ten inches up between the shoulder-blade and the ribs: This they call **boring**.

**BORING**, in mineralogy, a method of piercing the earth with scooping irons, which being drawn back at proper times, bring up with them samples of the different strata through which they have passed; by the examination of which the skilful mineralist will be able to guess whereabouts a vein of ore may lie, or whether it will be worth while to open a mine there or no.

**BORIQUE**, one of the Caribbee islands, lying south-east of Porto Rico, in  $64^{\circ} 30'$  W. long. and  $18^{\circ}$  N. lat.

**BORISSOW**, a town of Poland, in the dutchy of Lithuania, situated upon the river Berozina.

**BORISTHENES**, in geography. See **NIEPER**.

**BORITH**. See **KALI**.

**BORMIO**, a territory of the Grisons, in Italy, having the dominions of Venice on the south.

**BORNE**, a market-town in Lincolnshire, about 30 miles south of the city of Lincoln; in  $20'$  W. long. and  $52^{\circ} 40'$  N. lat.

**BORNEO**, a large island in the Indian ocean, situated between  $107^{\circ}$  and  $117^{\circ}$  E. long. and between  $7^{\circ} 30'$  N. lat. and  $4^{\circ}$  S. lat.

Its figure is almost round, and computed to be 2500 miles in circumference, and consequently containing a greater number of square acres than any island in the known world.

**BORNEO** is also the name of the principal town of the above island, situated on a bay at the north-west part, in  $111^{\circ} 30'$  E. long. and  $4^{\circ} 30'$  N. lat.

**BORNHOLM**, an island in the Baltic Sea, situated on the coast of Schonen, in Sweden, about 43 miles north-east of the island of Rugen, in  $15^{\circ}$  E. long. and  $55^{\circ} 15'$  N. lat.

**BORNEO**, or **BOURNOU**, the name of a town and country of Nigritia, in Africa. This country abounds in cattle, millet, and cotton. It lies between  $15^{\circ}$  and  $24^{\circ}$  E. long. and between  $10^{\circ}$  and  $20^{\circ}$  N. lat.

**BORNEO** is also the name of a lake, in the river Niger, where it traverses the above-mentioned country.

**BOROUGH**, in Scots law, is a body corporate made up of the inhabitants of a certain tract of ground erected by the sovereign, and endowed with a limited jurisdiction, and certain privileges. They are divided into boroughs royal, of regality, and of barony. See **LAW**, tit. *Inferior Judges and Courts of Scotland*.

**BOROUGH-ENGLISH**, a customary descent of lands or tenements, in certain places, by which they descend to the youngest instead of the eldest son; or, if the owner have no issue, to the younger instead of the elder brother. This custom goes with the land, although there be a devise or feoffment at the common law to the contrary. The reason of this custom, says Littleton, is, because the youngest is presumed in law to be least able to provide for himself.

**BOROUGH-HEAD**, or **HEADBOROUGH**, called also borough-holder, or burfholder, the chief man of the *decenna*, or hundred, chosen to speak and act in behalf of the rest.

Headborough also signifies a kind of head constable, where there are several chosen as his assistants, to serve warrants, &c. See **CONSTABLE**.

**BOROUGH-**

**BOROUGH-BRIDGE**, a town in the North Riding of Yorkshire, about 15 miles north-west of York; in 1° 15' W. long. and 54° 10' N. lat.

**BOROZAIL**, or the zail of the Ethiopians, a disease epidemic in the countries about the river Senega. It principally affects the pudenda, but is different from the lues venerea. It owes its rise to excessive venery: In the men this distemper is called *asab*, and in the women *asabat*.

**BORRAGE**. See **ANCHUSA**.

**BORRELLISTS**, in church-history, a Christian sect in Holland. They reject the use of churches, of the sacraments, public prayer, and all other external acts of worship. They assert, that all the Christian churches of the world have degenerated from the pure apostolical doctrines, because they have suffered the word of God, which is infallible, to be expounded, or rather corrupted, by doctors, who are not infallible. They lead a very austere life, and employ a great part of their goods in alms.

**BORSALO**, a kingdom of Africa, in Nigritia: It extends along the north side of the river Gambia, as far as Tantaconde.

**BOS**, in zoology, a genus of quadrupeds belonging to the order of pecora. The characters of this genus are taken from the horns and teeth. The horns are hollow within, and turned forward, in the form of crescents: There are eight fore-teeth in the under jaw, and none in the upper, their place being supplied by a hard membrane; and there are no dog-teeth in either jaw. Linnæus enumerates six species, *viz.* 1. The taurus, including the bull and cow, has cylindrical horns, bent outwards, and loose dewlaps. The bull or male is naturally a fierce and terrible animal. When the cows are in season, he is perfectly ungovernable, and often altogether furious. When chafed, he has an air of fullen majesty, and oft tears up the ground with his feet and horns. The principal use of the bull is to propagate the species; although he might be trained to labour, his obedience cannot be depended on. A bull, like a stallion, should be the most handsome of his species. He should be large, well made, and in good heart; he should have a black eye, a fierce aspect, but an open front; a short head; thick, short, and blackish horns, and long shaggy ears; a short and straight nose, large and full breast and shoulders, thick and fleshy neck, firm reins, a straight back, thick fleshy legs, and a long tail well covered with hair. Castration remarkably softens the nature of this animal; it destroys all his fire and impetuosity, and renders him mild and tractable, without diminishing his strength; on the contrary, after this operation, his weight is increased, and he becomes fitter for the purposes of plowing, &c.

The best time for castrating bulls is at the age of puberty, or when they are eighteen months or two years old; when performed sooner, they often die. However, it is not uncommon to castrate calves a few days after birth. But such as survive an operation so dangerous to their tender age, generally grow

larger and fatter, and have more courage and activity than those who are castrated at the age of puberty. When the operation is delayed till the age of six, seven, or eight years, they lose but few of the qualities of bulls, are much more furious and untractable than other oxen, and when the cows are in season, they go in quest of them with their usual ardor. See Plate LII. fig. 2.

The females of all those species of animals which we keep in flocks, and whose increase is the principal object, are much more useful than the males. The cow produces milk, butter, cheese, &c. which are principal articles in our food, and besides answer many useful purposes in various arts.

Cows are generally in season, and receive the bull, from the beginning of May to the middle of July. Their time of gestation is nine months, which naturally brings the veal or calves to our markets from the beginning of January to the end of April. However, luxury has fallen upon methods of interrupting this natural course, and veal may be had almost every month in the year.

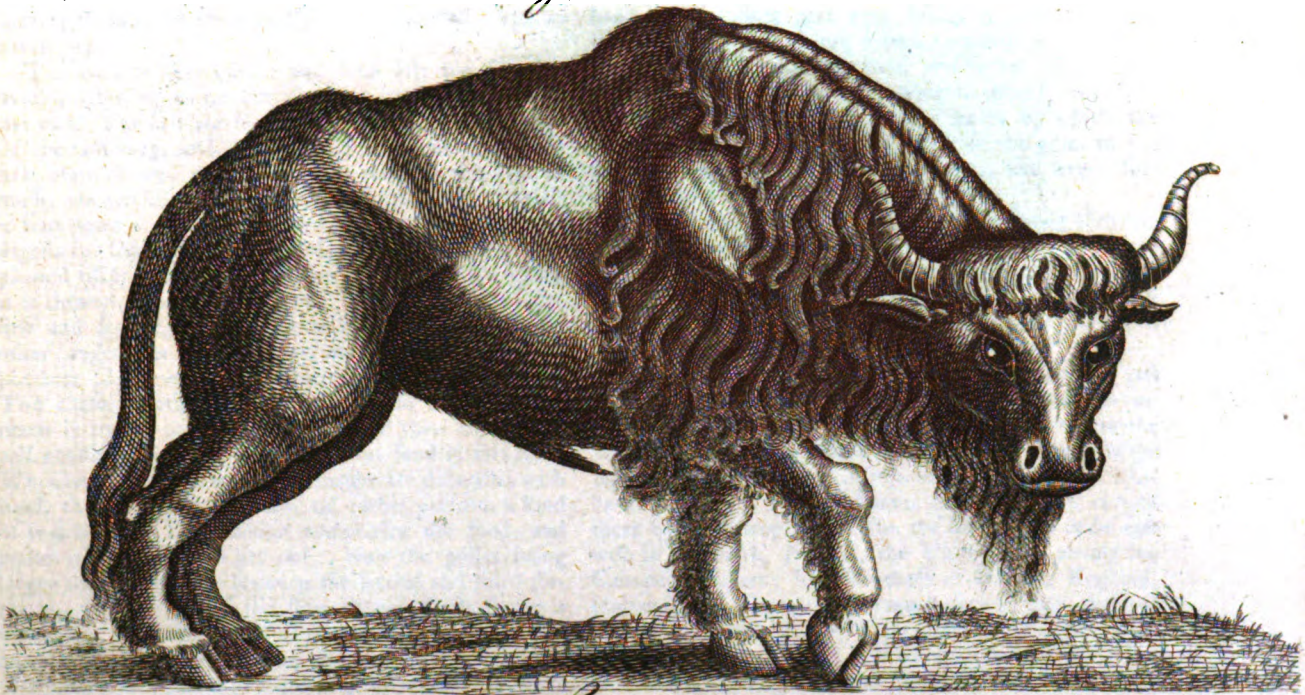
Cows, when improperly managed, are very subject to abortion. In the time of gestation, therefore, they ought to be observed with more than ordinary care, lest they should leap ditches, &c. Neither should they be suffered to draw in the plough or other carriage, which is a practice in some countries. They should be put into the best pasture, and should not be milked for six weeks or two months before they bring forth their young. The calve should be allowed to suck and follow its mother during the first six or eight days. After this it begins to eat pretty well, and two or three sucks in a day will be sufficient. But if the object be to have it quickly fattened for the market, a few raw eggs every day, with boiled milk, and a little bread, will make it excellent veal in four or five weeks. This management of calves applies only to such as are designed for the butcher. When they are intended to be nourished and brought up, they ought to have at least two months suck; because the longer they suck, they grow the stronger and larger. Those that are brought forth in April, May, or June, are the most proper for this purpose; when calved later in the season, they do not acquire sufficient strength to support them during the winter.

The cow comes to the age of puberty in 18 months, but the bull requires two years: But although they are capable of propagating at these ages, it is better to restrain them till they be full three years. From three to nine years those animals are in full vigour; but when older, they are fit for nothing but to be fed for the butcher. A milk cow ought to be chosen young, fleshy, and with a brisk eye.

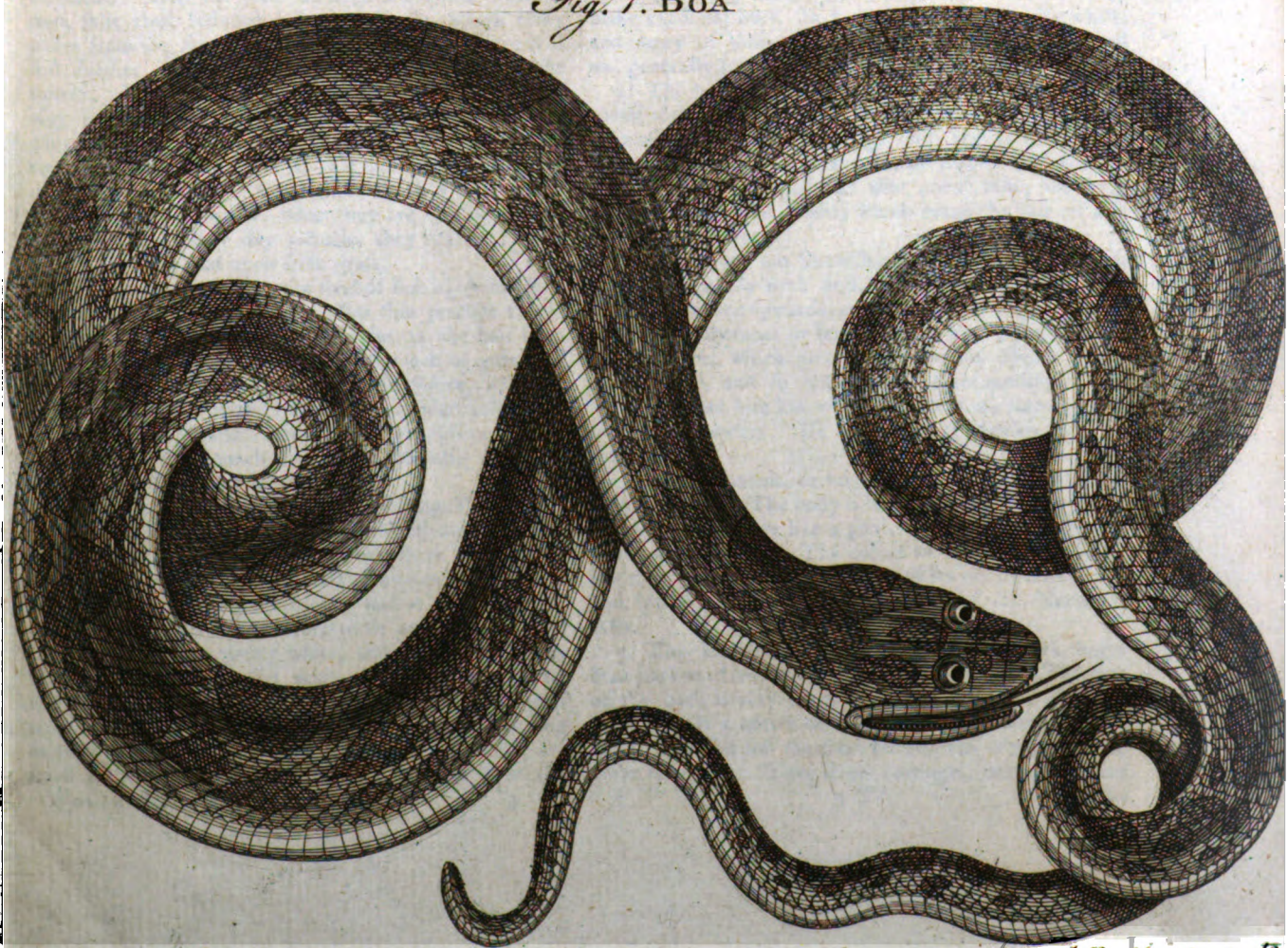
The heaviest and most bulky animals neither sleep so profoundly, nor so long as the smaller ones. The sleep of the ox is short and slight; he wakes at the least noise. He lies generally on the left side, and the kidney of that side is always larger than the other. There is great variety in the colour of oxen. A reddish or black colour is most esteemed. The hair should be glossy, thick, and soft; for, when otherwise, the animal is either not in health, or has a weakly constitution. The best time for

inaring





*Fig. 1. Boa*





inuring them to labour is at the age of two and a half or three years.

The ox eats very quick, and soon fills his first stomach; after which he lies down to ruminate, or chew the cud. The first and second stomachs are continuations of the same bag, and very capacious. After the grass has been chewed over again, it is reduced to a kind of mash, not unlike boiled spinach, and under this form it is sent down to the third stomach, where it remains and digests for some time; but the digestion is not fully completed till it comes to the fourth stomach, from which it is thrown down to the guts. The contents of the first and second stomachs are a collection of grass and other vegetables roughly macerated; a fermentation however soon commences, which makes the grass swell. The communication between the second and third stomach is by an opening much smaller than the gullet, and not sufficient for the passage of the food in this state. Whenever then the two first stomachs are distended with food, they begin to contract, or rather perform a kind of re-action. This re-action compresses the food, and makes it endeavour to get out: Now the gullet being larger than the passage between the second and third stomachs, the pressure of the stomach necessarily forces it up the gullet. The action of ruminating, however, appears to be in a great measure voluntary; as animals of this kind have a power of increasing the re-action of their stomachs. After the food undergoes a second mastication, it is then reduced into a thin pulp, which easily passes from the second to the third stomach, where it is still further macerated; from thence it passes to the fourth, where it is reduced to a perfect mucilage, every way prepared for being taken up by the lacteals, and converted into nourishment. What confirms this account of chewing the cud is, that as long as these animals suck or feed upon liquid aliment, they never ruminate; and in the winter, when they are obliged to feed upon hay and other dry victuals, they ruminate more than when they feed upon fresh grass.

Bulls, cows, and oxen, are fond of licking themselves, especially when lying at rest. But this practice should be prevented as much as possible; for as the hair is an undigestible substance, it lies in the stomach or guts, and is gradually coated by a glutinous substance, which in time hardens into round stones of a considerable bulk, which sometimes kills them, but always prevents their fattening, as the stomach is rendered incapable of digesting the food so well as it ought.

The age of these animals may be distinguished by the teeth and horns. The first fore-teeth fall out at the age of six months, and are succeeded by others of a darker colour, and broader. At the end of sixteen months, the next milk-teeth likewise fall out; and at the beginning of the fourth year all the fore-teeth are renewed, and then they are long, pretty white, and equal: However, as the animal advances in years, they become unequal and blackish. At the end of three years, the horns of oxen fall off, and new ones arise, which continue as long as they live. The horns of oxen four years of age are small pointed, neat, and smooth, but thickest near the

head: This thick part next season is pushed further from the head by a horny cylinder, which is also terminated by another swelling part, and so on, (for as long as the ox lives, the horns continue to grow); and these swellings become so many annular knots by which the age may easily be reckoned: But, from the point to the first knot must be counted three years, and every succeeding knot only one year.

Ox-beef is very nourishing, and yields a strong aliment; the flesh of a cow, when well fattened and young, is not much inferior. Bull-beef is hard, tough, and dry; for which reason it is not much used for food. Veal is well tasted, easy of digestion, and rather keeps the body open as otherwise.

The northern countries of Europe produce the best cattle of this kind. In general, they bear cold better than heat; for this reason, they are not so plenty in the southern countries. There are but few in Asia the south of Armenia, or in Africa beyond Egypt and Barbary. America produced none till they were carried there by the Europeans. But the largest are to be met with in Denmark, Podolia, the Ukrain, and among the Calmuck Tartars; likewise those of Ireland, England, Holland, and Hungary, are much larger than those of Persia, Turkey, Greece, Italy, and Spain; but those of Barbary are least of all. In all mountainous countries, as Wales, the Highlands of Scotland, the black cattle are exceedingly small, but hardy, and when fattened make excellent beef. In Lapland, they are mostly white, and many of them want horns. The bull, cow, and ox, generally live about 14 or 15 years.

2. The bonafus, has a long mane; its horns are bent round towards the cheek, and not above a span in length. It is about the size of a large bull, and is a native of Africa and Asia. When enraged, he throws out his dung upon dogs or other animals that annoy him; the dung has a kind of caustic quality which burns the hair off any animal it falls upon.

3. The bison, has likewise a long thick mane, which covers the whole neck and breast on each side. The horns are turned upwards, and exceedingly large; there is a large protuberance or bunch on the back; his eyes are red and fiery, which gives him a furious aspect. He is fierce, cruel, and so bold that he fears nothing. It is unsafe to hunt him but where the trees are large enough to hide the hunters. He is a native of Mexico and Florida.

4. The grunniens, or hog-cow, has cylindrical horns, bent backwards. The body is so hairy, that the hair hangs down upon its knees like a goat. The tail has a kind of mane on each side. The colour of the body is black; but the front is white. It has bristles on its back, tail, and hind-legs. It is an inhabitant of the North of Asia.

5. The bubalis, or buffalo, has large black horns bent backward and inward, and plain before. The hair on the back is very hard, but thinly scattered over the body. It is a native of Asia. But they are tamed in Italy, and used for the same purposes as black cattle in other countries. They draw carriages, and are guided

by a rope tied to a ring thrust through their noses. The buffalo is larger than an ox, has a thicker body, and a very hard hide. His pace is slow; but he will carry a great burden. They feed in herds like cows, and yield plenty of milk, of which very good butter and cheese is made. Their flesh is pretty good, but not to be compared to beef. The wild buffalo is a very fierce and dangerous animal; he often attacks travellers, and tears them to pieces. However, they are not so much to be feared in woods as in the plains; because their horns, which are sometimes ten feet long, are apt to be entangled in the branches of trees, which gives those who are surprised by them time to escape. They are excellent swimmers, and will cross the largest river without any difficulty. They run wild in great troops on the coast of Malabar, for which reason strangers are allowed to hunt and kill them at pleasure.

6. The indicus, or little Indian buffalo, has horns shorter than its ears, a bunch on its back, and no mane. It is about the size of a calf six months old, and used in the East Indies for drawing coaches, &c.

**BOSA**, or **Bossa**, a town of Sardinia, situated on its western coast, at the mouth of a river of the same name; in 8° 30' E. long. and 40° 15' N. lat.

**BOSCAGE**, the same with a grove, or thicket.

**Boscage**, in a law sense, is that food which trees yield to cattle, as mast, &c. But Manwood says, to be quit of boscage, is to be discharged of paying any duty for wind-fall wood in the forest.

**Boscage**, among painters, denotes a landscape representing much wood and trees.

**BOSCHETTO**, in geography, a territory in the isle of Malta: And likewise an estate belonging to the grand masters of that order, about two miles from Civita Vecchia, in Italy.

**BOSEA**, in botany, a genus of the pentandria digynia class. The calix consists of five leaves; it has no corolla; and the fruit is a dry, compressed, membranaceous berry. There is but one species, viz. the yervamora, a native of the Carribbee-islands.

**BOSNA-SERAJO**, the capital of the province of Bosnia, in 19° E. long. and 44° N. lat.

**BOSNIA**, a frontier province of Christendom, divided between the House of Austria and the Turks; that part of it lying eastward of the river Unna, belonging to the Turks; and the rest of it, lying westward of that river, to the Austrians.

**BOSPHORUS**, in geography, denotes, in general, a narrow sea, or channel, separating two continents, and serving as a communication between two seas.

**Bosphorus** is more particularly used for the straits of Constantinople, which divides Europe from Asia.

This was the original Bosphorus; so called because oxen could swim over it: And from the resemblance between it and the straits of Kassa, these last were anciently called the *Cimmerian*, as the former were the *Thracian Bosphorus*.

**BOSQUETS**, in gardening, groves so called from *boschetto*, an Italian word, which signifies a little wood.

They are compartments in gardens, formed by branches of trees, disposed either regularly in rows, or wildly and irregularly, according to the fancy of the owner. A bosquet is either a plot of ground inclosed with palisadoes of horn-beam, the middle of it being filled with tall trees, as elm or the like, the tops of which make a tuft or plume; or it consists of only high trees, as horse-chestnut, elm, &c. The ground should be kept very smooth and rolled, or else covered with grass, after the manner of green-plots. In planting bosquets, care should be taken to mix the trees which produce their leaves of different shapes, and various shades of green, and hoary or meally leaves, so as to afford an agreeable prospect. Bosquets are only proper for spacious gardens, and require a great expence to keep them up.

**BOSS**, or **Bosse**, in sculpture. See **RELIEVO**.

**BOSSAGE**, in architecture, a term used for any stone that has a projecture, and is laid rough in a building, to be afterwards carved into mouldings, capitals, coats of arms, &c.

Bossage is also that which is otherwise called rustic work, and consists of stones which advance beyond the naked, or level, of the building, by reason of indentures or channels left in the joinings. These are chiefly used in the corners of edifices, and thence called *rustic quoins*. The cavities or indentures are sometimes round, sometimes chain-framed, or beveled, sometimes in a diamond form, and sometimes inclosed with a cavetto, and sometimes with a listel.

**BOSSINEY**, a borough-town of Cornwall, situated on the Irish channel, about fifteen miles north-west of Launceston: W. long. 5°, and N. lat. 50° 40'.

It sends two members to parliament.

**BOSSORA**, or **Bassora**, a large port-town of Asiatic Turkey, in the province of Eyrac Arabic; situated on the western shore of the river Euphrates, about forty miles north-west of the gulph of Persia, or Bossora, in E. long. 47°, and N. lat. 30°.

**BOSSUPT**, a town of Brabant, in the Austrian Netherlands, about eight miles south of Louvain: E. lon. 4° 30', and N. lat. 50° 52'.

**BOSTANGIS**, in the Turkish affairs, persons employed in the garden of the seraglio, out of whose number are collected those who are to row in the Grand Signior's brigantines, when he has a mind to divert himself with fishing, or take the air upon the canal. They who row on the left hand are only capable of mean employments in the gardens; but they who row on the right hand may be promoted to the charge of *bostangi-bachi*, who has the general intendency of all the Grand Signior's gardens, and commands above ten thousand *bostangis*.

**BOSTON**, a port-town of Lincolnshire, situated near the mouth of the river Witham, about twenty-six miles south-east of Lincoln: E. long. 5', and N. lat. 53°.

**Boston**, is also the name of the capital of New-England, situated on a peninsula, at the bottom of a fine bay, covered with small islands and rocks, and defended by a castle and platform of guns: W. long. 71°, and N. lat. 42° 24'.

It is a flourishing town, wherein are ten churches,

six of them belonging to independents. The number of its inhabitants are computed to be about fourteen thousand.

**BOSWORTH**, a market town of Leicestershire, situated about eleven miles south-west of Leicester: W. long.  $1^{\circ} 25'$ , and N. lat.  $52^{\circ} 45'$ .

**BOTALE** *foramen*, in anatomy, a name given to the

*foramen ovale*, from Botall, physician to Charles IX. to whom the discovery of it is ascribed. See *FORAMEN ovale*.

**BOTANIST**, a person skilled in botany. See *Botany*.

**BOTANOPHILI**, persons who have treated of plants, not as botanists, but as gardeners, physicians, &c.

## B O T A N Y.

**BOTANY** is that branch of natural history which treats of the uses, characters, classes, orders, genera, and species of plants.

Before we explain the most approved method of di-

stinguishing plants, it will not be improper to inquire into the nature of the science, and what useful or ornamental purposes may be expected from the cultivation of it.

### SECT. I. USES OF BOTANY.

**WHEN** this science is carried no further than to distinguish one plant from another, its uses are few and uninteresting. However, even this exercise is attended with some advantages. It is the first, and a necessary step towards discovering those of a more noble kind. It is the rudiments of the science; and must therefore be acquired before we can expect to arrive at any improvement that may be useful to mankind. This part of botany is likewise more complete and systematic than many other branches of natural history. By means of the classical and generic marks, we are enabled in a few minutes to discover the name of any plant, from whatever quarter of the globe it may be brought. This is exceedingly curious, and altogether incredible to people unacquainted with the nature of the science. When we have learnt the name, we are then in a capacity of consulting authors with regard to the peculiar properties of the plant, so far as they are known.

Besides, there is an elegance and symmetry in plants, which give rise to many agreeable emotions. Their parts, like those of animals, are possessed of all the beauties of utility, regularity, uniformity, order, and proportion. Neither is there any class of natural bodies in which the beauty of variety makes such a capital figure. This variety is chiefly exhibited in the magnitude, figure, colour, odour, and taste of vegetables. It is therefore natural to expect, that the study of botany should have some influence in improving our taste.

But as botany is confessedly a branch of natural history, the botanist ought not to confine his researches to the mere names and characters of plants. He ought to inquire into their qualities. These qualities, indeed, when we talk of vegetables in general, are exceedingly numerous, and the investigation of many of them attended with such difficulty, that no person, however industri-

ous, can ever expect to unfold the whole. But this circumstance does not afford any argument for losing sight of utility altogether. On the contrary, it is the only thing that can give dignity to the science, or entitle it to be ranked as a branch of natural history. There is but little pleasure in studying a science which is already carried to its highest pitch of improvement. The prospect of discovering any thing that may be useful to mankind stimulates our industry, and makes us prosecute our researches with vigour and alacrity.

A botanist, or an inquirer into the nature and properties of vegetables, ought to direct his views principally towards the investigation of useful qualities. For this purpose, in examining plants, he should consider whether they be possessed of any qualities which may render them of use in food, in medicine, or in any of the arts. These are objects worthy the attention of philosophers. Let us examine the assistance that may be expected from the study of botany with regard to these important articles.

1. **FOOD**.—Many animals are endowed with an instinctive faculty of readily distinguishing whether the food that is presented to them be noxious or salutary. Mankind have no such instinct. They must have recourse to experience and observation. But these are not sufficient to guide us in every case. The traveller is often allured by the agreeableness of smell and taste to eat poisonous fruits. Neither will a general caution not to eat any thing but what we know from experience to be salutary, answer in every emergency. A ship's company, in want of provisions, may be thrown upon an uninhabited coast, or a desert island. Totally ignorant of the nature of the plants which they meet with;—diseases, or scarcity of animals, may render it absolutely necessary to make use of vegetable food;—the consequence is dreadful: They must

must first eat, before any certain conclusion can be formed. This is not the description of danger arising from an imaginary situation. Before the vegetables that grow in America, the East and West Indies, &c. became familiar to our sailors, many lives were lost by trials of this kind: Neither has all the information received from experience been sufficient to prevent individuals from still falling a prey to ignorance or rashness.

If the whole science of botany were as complete as some of its branches, very little skill in it would be sufficient to guard us infallibly from committing such fatal mistakes. There are certain orders and classes which are called *natural*, because every genus and species comprehended under them are not only distinguished by the same characteristic marks, but likewise possess the same qualities, though not all in an equal degree. For example: Shew a botanist the flower of a plant whose calix is a double-valved glume, with three stamina, two pistils, and one naked seed, he can pronounce with absolute certainty, that the plant from which the flower was taken bears seeds of a farinaceous quality, and that they may be safely used as food. In like manner, shew him a flower with twelve or more stamina, all inserted into the internal side of the calix; though it belonged to a plant growing in Japan, he can pronounce, without hesitation, that the fruit of it may be eat with safety. On the other hand, show him a plant whose flower has five stamina, one pistil, one petal or flower-leaf, and whose fruit is of the berry kind, he will tell you to abstain from eating it, because it is poisonous. Many other examples might be given: but we shall reserve them till we come to the medical qualities.

Facts of this kind make botany not only a respectable, but a most interesting science. The French and some other nations use a greater variety of vegetable food than the British. This practice is attended with many advantages. The greater number of vegetables that are made use of in any country, the poor have the greater number of resources when there happens to be a scarcity of any particular kind. It likewise affords an opportunity of a more universal cultivation. When agriculture or gardening is confined to few plants, there is great hazard from bad seasons and other unavoidable accidents, besides the certain loss arising from allowing such soils as are improper for raising the usual plants to lie unemployed. Though we are principally influenced by example in introducing the culture of new plants; yet the advice and direction of the botanist may be useful. From his knowledge of the qualities of plants that grow in other countries, he is enabled to guess, with tolerable exactness, whether they will agree with the soil or climate in which they are proposed to be cultivated. He can do more: he can point out what particular species of the plant will be most easily naturalized. Besides, without having recourse to the example of foreign countries, the botanist can point out a number of plants that grow wild in his own country, which might be cultivated with advantage, as food either for men or cattle. For example, in the whole class called *diadelphia* by Linnæus, which includes the *polygala*, or milk-wort; the *anthyllis*, or kidney-vetch;

the *orobus*, or heath-pease; the *lathyrus* and *vicia*, which comprehend a number of plants of the vetch-kind; the *ornithopus*, or bird's-foot; the *hedyfarum*, or St-foin; the *astragalus*, or wild liquorice; the *medicago*, or lucern; the *lotus*, or bird's-foot trifol, &c.; the leaves are excellent food for cattle, and the seeds may be used either by men or cattle. In like manner, all the seeds of the grass-kind, which belong to the triandria class of Linnæus, and are very numerous, make excellent food for men, and the leaves afford the best pasture for cattle. Many of the plants belonging to this class are not cultivated in this country, though we have a great variety of them growing wild.

It has been frequently observed, that poor people, during a scarcity of corn, have been induced to fill their bellies with substances that were both pernicious and loathsome, while they were trampling under their feet plants that would at once have afforded good nourishment and been highly grateful. This conduct could proceed from nothing but their ignorance of the nature and effects of these plants, and from their not being able to distinguish the noxious ones from the salutary. It is the duty of every man to point out the remedy for calamities of this kind, especially when it is not impossible that the causes which produced them may exist in some future period. For this purpose, we shall subjoin a short list of native plants that may be eat with safety and advantage.

*Salicornia Europæa*, or marsh-samphire, jointed glasswort, or saltwort. This plant grows plentifully near the sea-coasts, and eats very well with salt and vinegar.

*Veronica becabunga*, or common brook-lime. This plant, which grows in marshes, is commonly gathered in the spring, and eat as a salad.

*Valeriana locusta*, lamb's-lettuce, or corn-sallet, grows in corn-fields and pasture-grounds. The leaves are reckoned more wholesome than the common lettuce cultivated in our gardens.

*Scirpus maritimus*, or round-rooted cyperus, grows near the sea-shores. The root consists of a number of knots, which, after being dried and grinded, have been frequently used as bread when provisions were scarce.

*Bromus secalinus*, or field brome-grass, grows in vast quantities in rye-fields, especially after the rye is cut down. The seeds of this plant, mixed with grain of a better quality, make very good bread: But if the quantity of brome-grass seeds be great, the people who use the bread are apt at first to be affected with a slight degree of intoxication; but this effect ceases, after being a little accustomed to the food.

*Festuca fluitans*, or fote-fescue-grass, grows in ditches and marshy places. In Sweden and Germany, the seeds are used in broths and gruels, on account both of their nutritive quality and agreeable flavour. When grinded, and made into bread, they are esteemed little inferior to wheat or oats.

*Triticum repens*, common wheat-grass, dog's-grass, quick-grass, or couch-grass, grows so plentifully in our fields, that it is a great object with farmers to root it out. The roots of this plant, after being washed, dried, and grinded, have often been used as bread in a dearth of corn.

With

With regard to the other kinds of grass, the seeds of them may be safely used as food; but some of them are so small, that a sufficient quantity cannot easily be collected.

*Campanula*, or bell-flower. Nine or ten species of bell-flower grow in Britain. Both the roots and leaves, when boiled, especially before the stalk grows up, may be used.

*Chenopodium bonus henricus*, common English mercury, or all-good, grows almost every where. This plant is used in broth by the country-people, in place of cabbage or other pot-herbs. When the young leaves and stalks are dressed with butter, they are not inferior, in their flavour and nutritive power, to asparagus or spinach.

*Eryngium maritimum*, sea-holly, or eryngo, generally grows near the sea-shore. The young twigs, prepared as asparagus, are grateful to the taste, very nourishing, and give vigour to the body.

*Daucus carota*, wild carrot, or bird's-nest, grows in every field. It is the same species with the carrot cultivated in gardens, and is equally nourishing.

*Heracleum sphondylium*, or cow-parsnip. The inhabitants of Poland and Lithuania make a fermented liquor of the seeds and leaves, which the poorer sort use as ale. The inhabitants of Camscatka eat the stalks, after peeling off the bark.

*Carum carvi*, or caraways, grows in meadows and pasture-grounds. The young roots of this plant are more agreeable to the taste than the parsnip, and therefore might be of great service to the poor in a dearth of provisions.

*Convallaria polygonatum*, or sweet-smelling Solomon's-seal, grows in the cliffs of rocks. The roots are made into bread, and eat by the inhabitants of Lapland, when corn is scarce. The Turks use the young stalks as asparagus.

*Bunium bulbocastanum*, earth-nut, kipper-nut, pig-nut, or hawk-nut, grows plentifully on sea-grounds, the banks of rivers, sides of hills, &c. The roots are very sweet, afford excellent nourishment, and may be eat either raw, boiled, or roasted.

*Vaccinium uliginosum*, the great bilberry-bush, grows upon high grounds. The berries are much eat by children; but when taken in too great quantity, are apt to occasion a giddiness and headach.

*Vaccinium myrtyllis*, black whorts, whortle-berries, or bilberries, grows in woods. The berries have a fine flavour, and may be eat with safety.

*Vaccinium vitis idea*, red whorts, or whortle-berries, grows on hills. The berries are eat in the autumn, and many people make an excellent jelly of them.

*Polygonum viviparum*, small bistort, or snake-weed, grows upon high grounds. The roots may be prepared into bread. In Lapland and the northern parts of Europe, it is principally eat along with the flesh of stags and other wild animals.

*Spergula arvensis*, or corn-spurrey, grows in corn-fields, especially in sandy soils. In Norway, they collect the seeds of this plant, and make them into bread.

*Sedum rupestre*, or St Vincent's rock stone-crop, grows on high grounds. The Swifs cultivate this plant, and use it as a pot-herb.

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*Prunus padus*, wild cluster-cherry, or bird's-cherry, grows in woods and hedges. Some people eat the berries with salt.

*Prunus spinosa*, the black-thorn, or sloe tree, grows in hedges and woods. The berries are very austere; but the leaves are tender, and, when gently toasted, may be used in place of tea.

*Prunus cerasus*, or black-cherry, grows likewise in woods and hedges. The berries are eat both in a crude and dried state. When this plant is wounded, a gum exudes from it nearly of the same quality with gum-arabic. Dr Hasselquist informs us, that above 100 men, when besieged in an Egyptian town, were preserved alive for more than two months, without any other sustenance than they derived from the use of this gum.

*Cratægus aria*, or the white bean-tree, grows in woods. The berries are eat by the peasants; and in Sweden they are prepared and used as bread when there is a scarcity of corn.

*Cratægus oxycantha*, the white thorn, or hawthorn, grows every where in woods and hedges. The berries, when dried and grinded, are sometimes made into bread; but it is apt to bind the belly too much.

*Sorbus aucuparia*, the quicken-tree, or mountain-ash, grows in woods. Very good cyder is made of the berries; and, when dried, they make very wholesome bread.

*Rosa canina*, red-flowered dog's-rose, or hip-tree, grows in hedges. The berries afford excellent nourishment, and may either be eat in a crude state, or dried and made into bread.

*Spiræa filipendula*, or drop-wort, grows in pasture-grounds and the sides of hills. The roots of this plant, which are composed of small tubercles like pease, when dried and grinded, make tolerably good bread.

*Ranunculus ficaria*, pile-wort, or lesser celadine, grows in pasture-grounds, &c. The Norwegians collect the leaves in the spring, and use them in broth.

*Origanum vulgare*, or wild marjoram, grows in hedges and among brush-wood. The leaves of this plant, when toasted, and infused in boiling water, have such a resemblance to tea, that it is difficult to make a distinction. As tea is so universally used in diet, it is much to be regretted that the ladies cannot be prevailed upon to prefer this or some other of our own plants, and thereby save some millions sterling annually to their country.

*Stachys palustris*, or clown's all-heal, grows in marshes and the banks of rivers. The roots are succulent, and may be used either boiled, or dried and made into bread.

*Melampyrum arvense*, or purple cow-wheat, grows in corn-fields. Bread is sometimes made of the seeds; but it is a little bitter.

*Sinapis arvensis*, wild mustard, or charlock, grows plentifully in corn-fields, &c. The leaves of this plant are often used in broth.

*Crambe maritima*, or sea-colewort, grows in sandy ground near the sea-shore. The leaves, when young and tender, may be used in place of cabbage; but when too old, are apt to make the head giddy.

*Malva rotundifolia*, or dwarf-mallow, and *malva sylvestris*, or common mallow, are every where to be met with. The leaves of both these plants may be used in broth.

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Orobis

*Orobus tuberosus*, wood-pease, or heath-pease, grows in pasture-ground, woods, hedges, &c. The roots, when boiled, or made into bread, afford excellent nourishment.

*Pisum maritimum*, or sea-pease. In the year 1655, when a great famine prevailed in England, the poor people in Oxfordshire lived principally upon the seeds of this plant.

*Trifolium repens*, or white clover, grows in meadows and pasture-grounds. The flowers of this plant, when dried, make tolerably good bread.

*Trifolium pratense*, purple or honeyfuckle clover. The Scotch, when oppressed with a famine, used bread made of the flowers of this plant. And indeed bread may be made of the flowers of every plant belonging to the class called *diadelphia*, which comprehends near 600 species.

*Hipochrysis maculata*, or spotted hawkweed, grows on high pasture-grounds. The peasants of Norway use the leaves as cabbage.

*Sonchus oleraceus*, or common sow-thistle. The young leaves eat exceedingly well when boiled.

*Tragopodon pratense*, or yellow goat's-beard, grows in meadows and pasture-grounds. The roots, when dug up before the plant flowers, have a fine flavour, and are very nourishing.

*Aretium lappa*, or burdock. The young stalks, when the bark is taken off, eat, when boiled, like asparagus. Some people use them in a crude state, with oil and vinegar.

*Carduus palustris*, or marsh-thistle. Almost all the species of thistle may be used in the same manner as the burdock.

*Urtica dioica*, or common nettle. The use of this plant as a pot-herb is well known.

*Quercus robur*, or common oak. Acorns, during a famine, have often been made into bread.

*Fagus sylvatica*, or beech tree. Bread has sometimes been made of the nuts; but unless they be well dried, the bread made of them will produce a slight degree of intoxication.

*Corylus avellana*, or the hazel-nut tree. Every body knows the agreeable flavour and nutritive quality of hazel nuts.

*Pinus sylvestris*, or Scots fir. The Norwegians and others make bread of this tree in the following manner: They select such trunks as are most smooth and have least resin; they take off the bark, then dry it in the shade, and afterwards toast it over a fire, and grind it into meal. They generally mix with it a little oat-meal or barley. This bread, made of fir bark, is not only used in a scarcity of provisions, but is eat at all times by the poorer sort.

*Lichen islandicus*, or cryngo-leaved liver-wort, grows among heath and upon high grounds. The inhabitants of Iceland have long used this plant, both boiled, and in the form of bread.

*Lichen velleus*, or fleecy liver-wort, grows upon hills. In time of famine, the inhabitants used this plant for food.

Fungus, or mushroom. The species of this plant are very numerous. Some of them are used by the rich, rather as a seasoning, than as food. When taken in too great quantity, they are absolutely indigestible; and, unless thrown up from the stomach, will prove as fatal as the most deadly poison. The poor, therefore, who would be very apt to fall into this error, had better refrain from the use of mushrooms altogether.

From this short list of esculent plants that grow wild in our own country, we see how liberally we are provided with resources in case of a scarcity of the vegetables usually cultivated for food, and at the same time the advantages that might be derived from a very slight degree of knowledge in botany. Many of these plants grow best in soils which cannot be employed for raising corn of any kind. Besides, they are exceedingly hardy, and suffer but little from seasons, which in a great measure destroy the more delicate plants which we cultivate with so much labour and expence. It may be further remarked, that many improvements in agriculture and the useful part of gardening might be expected from propagating a taste for researches into the nature and properties of vegetables.

2. MEDICINE.—It is an unhappy circumstance, that the bulk of physicians in all ages have been more remarkable for their attachment to the abstruse and useless parts of the science, than to the nature and cure of diseases, the proper objects of their profession. Instead of disputing in folio how such a plant cures such a disease; had they exerted their industry and genius in ascertaining the fact, and then proceeded to make further inquiries into the qualities of other simples, the practice of physic would not have been a thing of such a fluctuating nature as it ever has been, and still continues to be.

Many practitioners, some of them men of considerable abilities, affect to despise the science of botany alledging that it affords no assistance to their art; and that it is very useless to load their memories with a long catalogue of hard names, without being a whit the wiser with regard to the medical properties. Besides, they imagine every single genus and species of the whole vegetable tribes to be possessed of peculiar and distinct properties; and that it would require the labour of a whole life-time to ascertain the virtues of a few plants.

It must indeed be confessed, that the writers and teachers of botany have not been sufficiently careful to prevent reflections of this kind. The technical part of the science ingrosses their chief attention: If the virtues are talked of, it is only in a cursory manner: The only thing that can render the science respectable, is either totally omitted in their systems, or dispatched in a line or two. But we are happy to find, that the science begins now to get some footing in this country. By the industry and spirit of a worthy Professor\*, the taste has been propagated

\* Dr John Hope professor of medicine and botany in the university of Edinburgh. Immediately after the Doctor's admission to the botanical chair, he offered gold and silver medals to his students for the best collections of indigenous plants



gated in a few years far beyond what could have been expected, especially when the state of the country before that period is taken into consideration.

We have no doubt of being able to shew, that botany, even in its present state, is so far from lying open to the objections brought against it by those who are either unacquainted with it, or affect to despise it as useless and trifling, that we have little reason to hope for any extensive insight into the medical virtues of plants by any other means.

In order to bring the numerous tribes of vegetables under certain classes or denominations, various methods have been adopted by different authors. Some have classed them by the figure of their roots; some by the caulis or stems; some by the leaves. Linnæus has preferred the parts of fructification, because these are not only the most essential, but likewise the most universal.

This method of classing is preferable to any that has been proposed, on many accounts. It is found by experience, that plants which are distinguished by the same characters in the flower and fruit, have precisely the same qualities, though not always in an equal degree as to strength or weakness; so that, upon inspection of the flower and fruit, a botanist can determine *à priori* the effects that will result from the plant when taken into the stomach. Here then is a foundation for natural classes. In order, therefore, to determine the medical virtues of all the plants belonging to a natural class, the physician has nothing further to do than to ascertain, by a set of clear and unquestionable experiments, the virtues of any one of them. This greatly shortens the labour of investigation. Supposing the number of known species to be 20,000, by ascertaining the virtues of one genus, at a medium, you determine the virtues of 12 species. But, by ascertaining the virtues of one genus belonging to a natural order, the virtues of perhaps 300 or 400 species are ascertained. Again, by ascertaining the virtues of one genus belonging to a natural class, you discover the virtues of perhaps 800 or 1000 species.

As this branch of the materia medica has been hitherto greatly neglected, we shall subjoin a few examples of natural orders and classes, with the virtues they are supposed to possess.

The *STELLATÆ* of Mr Ray, which make the 44th natural order of Linnæus, are said to be all diuretics. Of these, the *rubia* and *asperula* are remarkable for their diuretic and detergent qualities, and as such are admitted into both the Edinburgh and London dispensaries. The *aparine*, *gallium*, &c. possess the same qualities, though not perhaps in an equal degree.

The *ASPERIFOLIÆ* of Ray, belong to the pentandria monogynia class, with one petal and four seeds, of Linnæus, and form his 43d natural order. The plants of this order are said to be astringent and vulnerary. Under it the following genera are comprehended: *Tourne-*

*fortia*, *cerinthe*, *symphytum*, *pulmonaria*, *borrago*, *cy-noglossum*, *anchusa*, *lithospermum*, *myosotis*, *heliotropium*, *asperugo*, *lycopsis*, *echium*.

The plants included under the *PENTANDRIA*, with one stylus, one flower-leaf, and which bear berries, form the 33d natural order, and are generally poisonous. To this order belong all the solana, or night-shades; the *mandragora* and *atropa*, which are well known to be poisonous; the *hyoscyamus* and *datura* occasion madness and death; the *verbascum* intoxicates and kills fishes.

The *UMBELLATÆ*, which make the 22d natural order, are said to be aromatic, resolvent, and carminative, especially those that grow in a dry soil; but such of them as grow in a wet soil are said to be poisonous. The virtues reside in the roots and seeds. To this order belong the *daucus creticus*, *gentiana alba*, *siler montanum*, *ammi verum*, *petroselinum macedonicum*, &c.

The roots of the plants belonging to the *HEXANDRIA* class, are either esculent or poisonous. These qualities may be distinguished by the taste and smell. In the 7th, 8th, 9th, and 10th natural orders, the following poisonous plants of the hexandria class are enumerated, *viz.* the *leucoium*, *galanthus*, *pancratium*, *amaryllis*, *fritillaria*, *corona imperialis*, *gloriosa*, *convallaria*, *hyacinthus*, *aloes*, &c. The *allium*, *cepa*, and *parum*, are acrid; and, when taken in too great a quantity, are highly corrosive; but, as this hurtful quality is owing to a volatile alkaline substance in the roots, when they are roasted or boiled it flies off, and they may be eat with safety.

The fruit of all the plants belonging to the *ICOSANDRIA* class, which are enumerated in the 36th, 37th, 38th, and 39th natural orders, are esculent, and not one of them poisonous. To this class belong the *eugenia*, *punica*, *cerafus*, *crategus*, *pyrus*, *rosa*, *fragaria*, &c.

The plants belonging to the *POLYANDRIA* class, or the 23d natural order, are mostly poisonous, *e.g.* the *nymphæa*, *argemone*, *papaver*, *actæa*, *boconia*, *euphorbia*, *delphinium*, *staphisagria*, *aconitum*, *nigella*, *errhina*, *aquilegia*, *helleborus*, &c.

The leaves of the plants belonging to the *DIDYNAMIA GYMNOSPERMIA*, or 58th natural order, are said to be cephalic and resolvent. This order contains the *ajuga*, *teucrium*, *hyofopus*, *lavendula*, *mentha*, *lamium*, *betonica*, *ballota*, *leonurus*, *origanum*, *thymus*, *melissa*, *dracocephalum*, &c.

The plants belonging to the *TETRADYNAMIA* class, or the 57th natural order, are antiscorbutic, and a little acrid; *e.g.* the *lepidium*, *cochlearia*, *raphanus*, *cardamine*, *sinapis*, *erysimum barbarea*, *silybrium*, &c.

All the plants of the *MONODELPHIA* class, which form the 34th natural order, are emollient and mucilaginous. Whoever knows the qualities of the *althea* and *malva*, knows the qualities of the whole class, which comprehends about 180 species. The emollient and mucilaginous virtues are not confined to the leaves or any par-

plants prepared in the manner of a *hortus siccus*. The consequence of this plan fully answered his expectations. In a few years, he was in possession of many more plants than were ever formerly supposed to grow in Scotland. After this acquisition, the Dr judiciously changed the object of his medals, and offered them for the best accounts of the sensible qualities and medical virtues of any number of native plants. But we are sorry to find, that no gentlemen have hitherto become candidates for these medals since they were offered upon this sensible and useful plan.

particular part, but are diffused through the whole plant.

The *DIADELPHIA* class forms the 55th natural order. This class comprehends above 500 species; and, as was observed above, the seeds of every one of them are esculent, the leaves afford excellent pasture for cattle, and not one of them have any poisonous quality.

The *SYNGENESIA* class, or 21st natural order, contains a very great number of species. The virtues of some plants belonging to this class are said to differ considerably. The *bardana*, *carlina*, *tusilago*, *arnica*, *cichorium*, *scorzonera*, *taraxacum*, &c. are supposed to be deobstruent, and are kept as such in the shops. But the greatest number of them are bitter and stomachic; *e. g.* the *absinthium abrotanum*, *artemisia*, *fantolina*, *balsamita*, *tanacetum eupatorium*, *matricaria*, *chamomilla*, *acmella*, *verbescina*, &c.

The *GYNANDRIA DIANDRIA*, or 4th natural order, are said to excite venery; *e. g.* the *orchis*, *satyrium*, *serapias*, *herminium*, *ophrys*, *epidendrum*, &c. The roots of these are used with this intention by practitioners.

The *AMENTACEÆ ACIFOLIÆ*, or 15th natural order, are resinous; *e. g.* the *pinus*, *abies*, *juniperus*, *cupressus*, &c. They are all warm stimulant and diuretics.

The virtues of the *CRYPTOGAMIA* class, which comprehends the 61st, 62d, 63d, and 64th natural orders, are mostly of a suspicious nature. Hardly any of the filices are esculent; their smell is disagreeable, and they are said to kill worms. All the musci, except the *lichen islandicus*, are improper for food. Some of the fungi are eat; but they are a very dangerous food.

Plants which have their nectaria separate from the flowers, are commonly poisonous; *e. g.* the *epimedium*, *nigella*, *aquilegia*, *aconitum*, *monotropa*, *helleborus*, &c.

Those plants which are called *lactescens*, from their oozing out a whitish juice upon being wounded, are generally poisonous; *e. g.* the *euphorbia*, *papaver*, *periploca*, *cynanthum*, &c. But those which are called *semiosculosa* by Tournefort, are of a milder nature; *e. g.* the *lactuca*, *hieracium*, *crepis*, *leontodon*, &c.

Besides natural classes and orders, which presuppose some acquaintance with botany, we are provided with other means of discovering the general qualities of plants. The sensations of smell and taste give us some intimation of the nature and qualities of plants. An agreeable taste or smell is seldom accompanied with noxious qualities; on the other hand, when these senses are disagreeably affected, the qualities are generally more or less noxious, being either purgative, emetic, or poisonous. Plants that have a sweet taste are generally nutritive; those that have a salt taste are warm and stimulant. Plants of an acrid taste are corrosive; but, when deprived of their acrimony by drying, some of them become fit for food. Bitter plants are alkaline, stomachic, and sometimes of a suspicious nature. Acid plants are cooling, and allay thirst; but those of an austere taste are astringent.

Even the colour and aspect of plants throw some light upon their nature. Flowers or fruit of a red colour are generally acid. Yellow flowers indicate a bitter taste. Plants that have green flowers are crude; those of a pale

colour are commonly insipid; those of a white colour are generally sweet; and those whose flowers have a gloomy and dismal aspect, are mostly poisonous.

These examples naturally suggest the following observations.—The Creator of the universe hath endowed us with sufficient abilities for investigating the virtues of plants, and applying them to the cure of diseases and other useful purposes, even on the supposition that we were obliged to ascertain the virtues of every single plant by experiments. But this labour, though practicable in a course of years, and under proper regulations, is greatly abridged. The information afforded by the senses is considerable. Our inquiries are still further assisted by the general distribution of vegetables into tribes and families. The mutual relation and connection of these tribes depend not upon fancy or conjecture: The relations are so strongly marked by the similarity of their flowers, fruit, and sensible qualities, that they are conspicuous at first sight.

A person unacquainted with medicine, from this view of the virtues of plants, will be apt to imagine, that botany is the only road to that science; and of course that every physician must either be a good botanist, or a bad practitioner. The thought is natural, and, with some limitation, not unjust. The common practice of physic does not require an extensive skill in the virtues of plants. A certain number of vegetables and other substances are kept in the shops, and recommended for particular purposes in dispensaries and books of practice. It is the business of the practitioner to have a general acquaintance with these, and to prescribe them according to the custom of the times. But investigations into the nature and properties of simples or drugs, require more time than can be bestowed by men of business. Whenever any science is converted into a trade, and the study of it confined to people who must live by it, there is little prospect of improvement. This has been the fate of physic. Every body dispenses medicines; but few are none inquire into their virtues. Some valuable medicines have been discovered. But by whom? Not by physicians, but by savages, old women, priests, and chymists. Until, therefore, the study of physic be considered as a branch of natural history, and cultivated by people who have time to make experiments, the science must continue to be vague, desultory, and limited in its utility.

Botany has always been considered as a branch of natural history. But, as was formerly observed, the useful part of it hath been too much neglected. The virtues of plants may be successfully investigated without an extensive knowledge in all the branches of the medical art. To propagate a taste for inquiries into the nature and properties of vegetables, would therefore lay the most solid foundation for improvements in medicine.

3. ARTS.—The application of the qualities of vegetables to the various mechanical arts affords a most extensive field for useful observation. There are few plants, however different in their nature, but are found by experience to be not only the most proper, but essentially necessary, in some particular art or employment.

The qualities which render vegetables so generally applicable to mechanical employments are principally these:  
Softness

Softness or hardness of texture, elasticity, inflammability, astringency, colour, &c. Hence some plants are proper for domestic utensils, others for dying, tanning, &c. Some may be apt to think that qualities of this kind are not the proper objects of botany. But if the natural historian be at liberty to neglect useful qualities, he deserves little thanks for expatiating on those that are useless. It would be foreign to our design in this place, to enumerate the particular plants that are used for the various purposes of the mechanic. We shall however, by way of specimen, subjoin a list of plants that change the colour of cloths and other substances.

LIST OF DYING PLANTS.

Y E L L O W.

*Curcuma*, or turmeric. This plant grows in the East Indies; the root of it tinges a rich yellow colour; but it is not very durable.

*Rumex maritimus*, or golden dock, grows on roadsides, &c. The root dyes a fine yellow.

*Thalictrum flavum*, or meadow-rue, grows in marshes, on the banks of rivers, &c. Both the root and the leaves dye a very deep yellow.

*Urtica dioica*, or common nettle. The country people dye eggs a beautiful yellow with the roots of this plant at the feast of Easter.

*Santalum album*, or white sanders. The wood of this tree, which is a native of the East Indies, dyes a good yellow.

*Lawsonia inermis*, or alkanna, is a small shrub cultivated in Asia and Africa. The stem and branches of this plant afford an excellent yellow; the natives paint their bodies with it. The root, prepared with quick-lime, gives a fine shining red. The natives use it for dying their teeth, nails, faces, the mains of their horses, leather, &c.

*Morus tinctoria*, or fustic, grows in America. The wood of this tree is in great esteem among dyers for the fine yellow it affords.

*Rhamnus frangula*, or the black berry-bearing alder, grows in woods and hedges. The bark tinges a dull yellow; and the unripe berries dye woollen stuffs green.

*Rhamnus catharticus*, or purging buck-thorn, grows wild in woods and hedges. The bark gives a beautiful yellow.

*Rhamnus minor*, grows in the southern parts of Europe. The berries give an excellent yellow.

*Rhus Coriaria*, or sumach, grows in Italy, &c. The bark of the stem gives a yellow colour, and the bark of the root a yellowish red.

*Berberis vulgaris*, barberry or pimperidge-bush. The root of this plant gives an excellent yellow to cloth; and the bark gives leather a beautiful yellow colour.

*Prunus domestica*, or common plumb-tree. The country people use the bark for dying their cloth yellow.

*Pyrus malus*, or apple-tree. The dyers use the bark for giving cloth a yellow colour.

*Carpinus betulus*, the horn or hard-beam tree, horse or horn-beach tree, grows in woods. The bark is used as a yellow dye.

*Reseda luteola*, or base-rocket, grows in pasture-grounds, meadows, and especially on a chalky soil. This herb, which is a native of Scotland, gives cloth a most beautiful yellow colour, and is much used by dyers, who import it in large quantities, though it might be easily cultivated in our own country.

*Serratula tinctoria*, or saw-wort, grows in woods and meadows. This plant gives the same colour with the *reseda*, and, though not so beautiful, is much used by dyers.

*Hierachium umbellatum*, or narrow-leaved bushy hawkweed, grows in woods, hedges, and gravelly soils. This plant gives a very fine yellow.

*Acanthus mollis*, is a native of Italy. It appears that this plant was used by the ancients for dying yellow:

*Et circumtextum croceo velamen acantho.* VIRG.

*Bidens tripartita*, or trifid water-hemp-agrimony, grows in marshy places. This plant gives a pretty elegant yellow.

*Xanthium strumarium*, or lesser burdock, grows near dunghills. When this plant is boiled entire, together with the fruit, it gives a pretty good yellow.

*Salix pentandra*, or sweet willow. The dried leaves give a fine yellow.

*Betula alba*, or birch-tree. The leaves give a faint yellow colour to cloth.

*Stachys silvatica*, or hedge-nettle, grows in woods and hedges, and gives a yellow colour to cloth.

*Centaurea jacea*, or common knapweed, grows in pasture and barren grounds. This plant is often used as a succedaneum for the *ferratula* or saw-wort.

*Polygonum perficaria*, dead or spotted arsmart, grows in corn-fields, &c. and dyes cloth yellow.

*Lyfimacha vulgaris*, yellow willow-herb, or loose-strife, grows in marshes, and on the banks of rivers. This herb laid to dye yellow.

*Scabiosa fuccifa*, or devil's-bit, grows in meadows and pasture-grounds. The dried leaves give a yellow colour, but it is seldom used.

*Anthyllus vulneraria*, kidney-vetch, or ladies-finger, grows on dry pasture-grounds. The country people use this plant for dying their cloth yellow.

*Lichen juniperus*, or juniper-liverwort, grows on the trunks and branches of trees. *Lichen parietinus*, or common liver-wort, grows on walls and the bark of trees. *Lichen candelarius*, or yellow liverwort. These three species of liverwort are used by the common people for dying their stuffs yellow.

*Anthemis tinctoria*, or common ox-eye, grows on high grounds. The flowers give a bright yellow colour.

*Chærophyllum sylvestre*, wild cicely, or cow-weed, grows in hedges, &c. The umbel or tops and flowers of this plant give an excellent yellow.

*Thapsia villosa*, or deadly carrot, grows in Spain; and its umbel is used as a yellow dye by the inhabitants of that country.

*Genista tinctoria*, green wood, dyers-weed or wood-waxen, grows in pasture-grounds, &c. The flowers are much used as a yellow dye.

*Hypericum perforatum*, or St. John's wort, grows among brush-wood and in hedges. The flowers are used as a yellow dye, but it is not much esteemed.

*Calendula officinalis*, or garden marygold. The dried flower-leaves are sometimes used as a yellow dye: Their expressed juice, boiled with alum, makes an excellent yellow paint.

## R E D.

*Rubia tinctorum*, or madder, grows in the southern parts of Europe. The roots are much used by dyers for giving a red colour to cloth.

*Gallium boreale*, or crosswort madder; *gallium verum*, yellow ladies bed-straw, or cheefe-rening. Both these plants grow plentifully in our own country; and their roots are used for dyeing cloth red.

*Lithospermum tinctorium*, grows in France. The root gives a red colour, but it is not easily fixed.

*Rumex acetosa*, or common sorrel, grows in meadows and pasture-grounds. The root is used by apothecaries for tinging decoctions, &c. with a red colour; but it is not used by dyers.

*Cæsalpina Brasiliensis*, or Brasil wood, is a native of the East Indies. The wood is commonly used by the dyers for giving a red colour.

*Calamus rotang*, or dragon's blood, is an East-India fruit. The inspissated juice is principally used by apothecaries for giving a red tinge to their medicines.

*Bixa orellana*, grows in both the Indies. The seeds of this tree are much used as a red dye, and the natives of America paint their bodies with them.

## P U R P L E.

*Cæsalpinia vesicaria*. The wood of this tree gives a purple dye. The *cæsalpinia sappan* is used for the same purpose. The *lignum rubrum*, or Fernambuca wood, gives likewise a reddish purple dye.

*Origanum vulgare*, or wild marjoram, grows in woods, &c. The tops of this plant are used for dyeing cloth purple.

*Carthamus tinctorius*, is an annual plant, and a native of Egypt. The corollæ of this plant give a fiery red colour to cloth; but they are principally used for dyeing silks.

## B L U E.

*Isatis tinctoria*, or woad. This plant grows wild in corn-fields, and gives a blue colour to cloth.

*Indigofera tinctoria*, or indigo, grows in the East Indies. The blue dye given to cloth by this plant is preferable to any other; because it is of so fixed and durable a nature, that it is not affected either by acid or alkaline substances.

*Galega tinctoria*, is a perennial plant of Zeylon. Hermannus affirms, that the blue obtained from this plant is even preferable to the indigo, although it has never hitherto been used by Europeans.

*Fraxinus excelsior*, or common ash-tree. The bark tinges water blue; and the inner bark is said to give cloth a very good blue colour.

## V I O L E T.

*Hæmatoxylon campechianum*, or logwood, grows in the West Indies, and gives cloth a violet colour. It is, however, chiefly used as a basis for some other colours.

*Empetrum nigrum*, black-berryed heath, crow or crack-berries, grows on high grounds. The berries, boiled with alum, are used as a purple dye.

## G R E E N.

*Senecio jacobæa*, or common raywort, grows in pasture-grounds, &c. The whole plant is used, before it begins to flower, for dyeing cloths green.

*Chærophyllum sylvestre*, or wild cicely. This plant, when the tops are taken off, dyes cloth a beautiful green.

*Iris germanica*, grows in the southern parts of Europe. The expressed juice of the corolla gives a green dye.

## B L A C K.

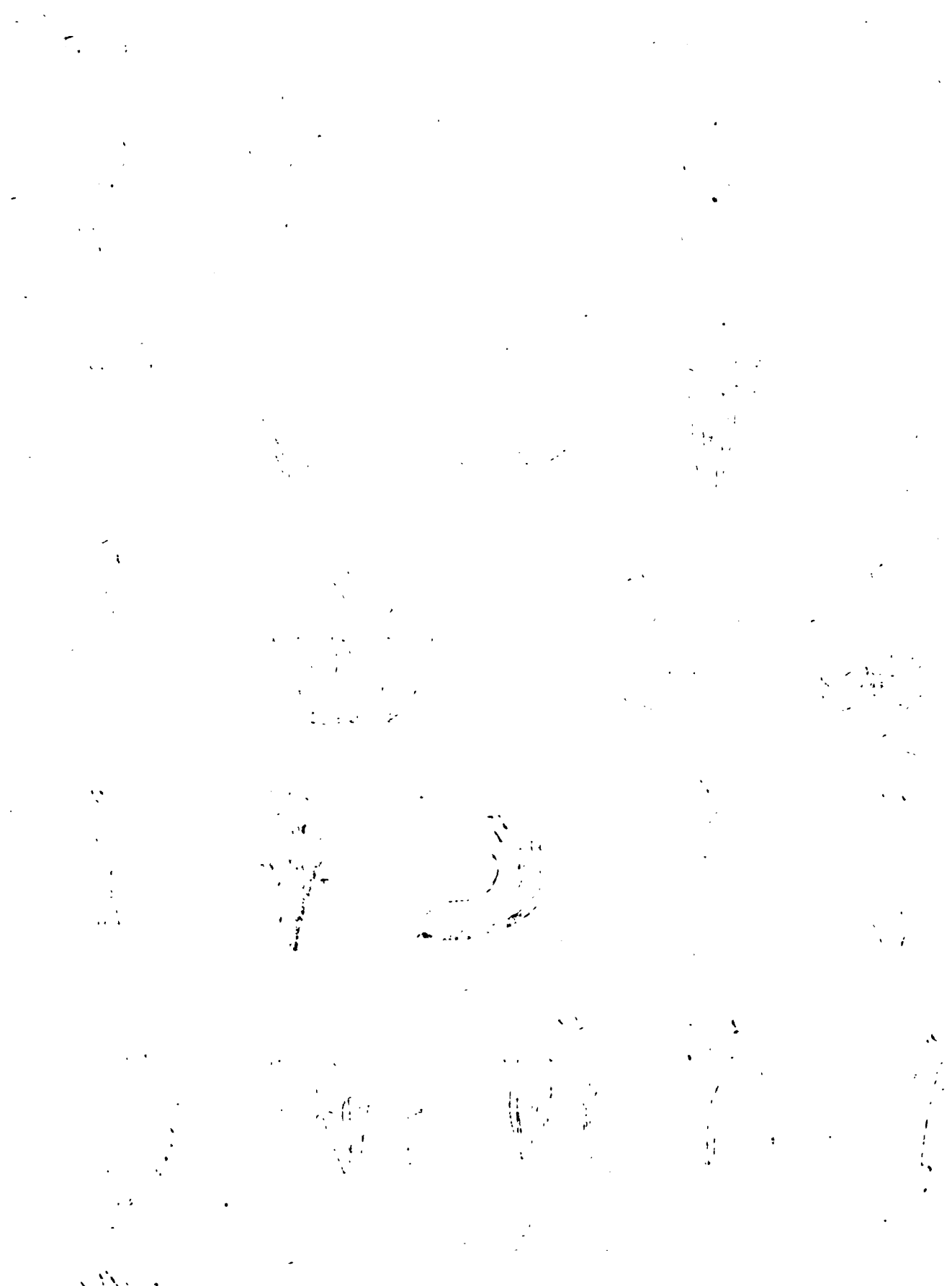
*Lycopus europæus*, or water horchound, grows in marshy places. The juice of this plant gives a black dye of such a fixed nature, that it cannot be washed out.

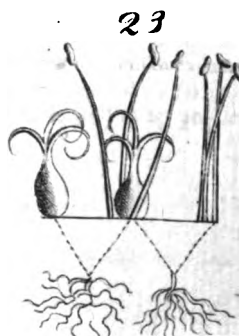
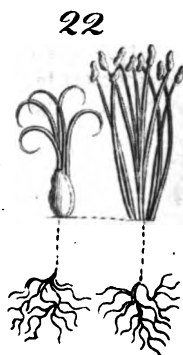
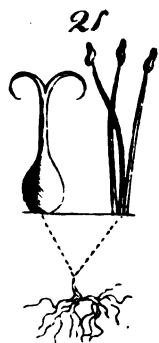
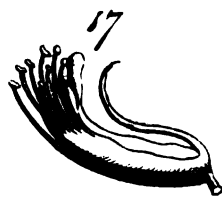
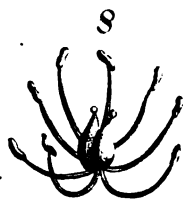
*Astæa spicata*, herb-christopher, or barberries, grows among brushwood. The juice of the berries, when boiled with alum, affords a fine black ink.

*Genipa americana*, is an American tree. The unripe berries tinge cloths with a deep black. The natives dye their mouth with these berries, to give them a terrible aspect to the enemy. It remains fixed for many days.

*Quercus*, or oak-tree. The capsulæ of the oak, or acorn of their great stipticity, are used for fixing and improving the mineral black. They are used both by dyers and curriers.

THIS short sketch of the utility of botany with regard to Food, Medicine, and the Arts, will be sufficient to suggest the many advantages that may be expected from the cultivation of it. The objects presented by the science are curious, respectable, and useful. The natural history of plants is not even confined to the above important articles. It is strictly connected with agriculture and gardening. The structure of vegetables, the soils that naturally produce particular kinds, things that promote or retard their growth, are essential parts of their natural history. Hence a school of botany, especially when sufficient attention is paid to the useful part of the science, merits the highest encouragement from the public, and ought to be attended by farmers, landed gentlemen, gardeners, &c. as well as by physicians and philosophers.





S E C T. II. *Of the METHOD of reducing PLANTS to CLASSES, ORDERS, GENERA, and SPECIES; and of investigating their GENERIC and SPECIFIC NAMES by certain MARKS or CHARACTERS.*

WE observed in the former section, that in the progress of this part of botany many different methods had been followed by different authors. Cæsalpinus, Ray, Bauhinus, Van Royan, Ricinus, Tournefort, Linnæus, Sauvages, have each adopted a peculiar method of characterizing and classing plants. It would be foolish to distract the attention of the reader by an explanation of all these methods. We shall therefore proceed to explain that of Linnæus, which is perhaps the only one now taught in Europe.

This method of reducing plants to classes, genera, and species, is founded upon the supposition that vegetables propagate their species in a manner similar to that of animals. Linnæus endeavours to support this hypothesis

by the many analogies that subsist between plants and animals, which shall be more particularly pointed out in the third section. It is from this circumstance that Linnæus's system of botany has got the name of the *sexual system*. The names of his classes, orders, &c. are all derived from this theory. He calls the stamina of flowers the *males*, or the male parts of generation; and the pistils *females*, or the female parts of generation. Plants whose flowers contain both male and female parts, are said to be *hermaphrodites*, &c. His classes, orders, and genera, are all derived from the number, situation, proportion, and other circumstances attending these parts, as will appear from the following scheme.

S C H E M E of the SEXUAL SYSTEM. See Plate LIII.

- PLANTS celebrate their nuptials,
- Either publicly, *i. e.* have visible flowers.
- 1. *Monœclinia*, males and females in the same bed:—*i. e.* The flowers are all hermaphrodite, having stamina and pistils in the same flower.
    - Diffinitas*, the males or stamina unconnected with each other.
      - Indifferentissimus*, the males or stamina having no determinate proportion betwixt each other as to length.
        1. MONANDRIA, *i. e.* one male or stamen in a hermaphrodite flower.
        2. DIANDRIA, — two males or stamina.
        3. TRIANDRIA, — three males.
        4. TETRANDRIA, — four males.
        5. PENTANDRIA, — five males.
        6. HEXANDRIA, — six males.
        7. HEPTANDRIA, — seven males.
        8. OCTANDRIA, — eight males.
        9. ENNEANDRIA, — nine males.
        10. DECANDRIA, — ten males.
        11. DODECANDRIA, — eleven males.
        12. ICOSANDRIA, — twenty, or more males inserted into the calix, and not into the receptacle.
        13. POLYANDRIA, — all above twenty males inserted into the receptacle.
  - 2. *Subordinatio*, two of the males or stamina uniformly shorter than the rest.
    14. DIDYNAMIA, — four males, two of them uniformly shorter than the other two.
    15. TETRADYNAMIA, — six males, two of which are uniformly shorter than the rest.
2. *Affinitas*, the males or stamina either connected to each other, or to the pistillum.
  16. MONODELPHIA, the males or stamina united into one body by the filaments.
  17. DIADELPHIA, the stamina united into two bodies or bundles by the filaments.
  18. POLYADELPHIA, the stamina united into three or more bundles by the filaments.
  19. SYNGENESIA, the stamina united in a cylindrical form by the antheræ.
  20. GYNANDRIA, the stamina inserted into the pistillum.
- Diœclinia*, males and females in separate beds; *i. e.* plants that have male and female flowers in the same species.
21. MONOECIA, male and female flowers in the same plant.
  22. DIœCIA, male flowers in one plant, and females in another, of the same species.
  23. POLYGAMIA, male, female, and hermaphrodite flowers in the same species.
- Or clandestinely, *i. e.* whose parts of fructification are invisible.
24. CRYPTOGAMIA, the flowers invisible, so that they cannot be ranked according to the parts of fructification.

These.

These twenty-four classes comprehend every known genus and species. It is an easy matter to class a plant belonging to any of the first eleven classes, as they all depend on the number of stamina or male parts, without regard to any other circumstance. The 12th class requires more attention. When the stamina amount to above 20, a tyro will be apt to imagine that the plant belongs to the polyandria class. In reducing plants of this kind to their classes, particular regard must be had to the insertion of the stamina. If they are inserted into the calix or cup, the plant belongs to the icofandria class; if to the receptacle or basis of the flower, it belongs to the polyandria.

The 14th class is likewise in danger of being confounded with the 4th. In the 4th, the number of stamina is the same with that of the 14th. But, in the 14th, two of the stamina are uniformly much shorter than the other two; at the same time each particular stamen belonging to the different pairs stands directly opposite to one another.

The 15th class may be mistaken for the sixth, as they consist of the same number of stamina. But in the 15th, four of the stamina are uniformly longer than the other two; and these two are always opposite to each other.

### ORDER S.

In the first thirteen classes, the orders, which are inferior divisions, and lead us a step nearer the genus, are taken from the pistils or female parts, in the same manner as the classes from the stamina: Monogynia, digynia, trigynia, tetragynia, &c. *i. e.* one, two, three, four, &c. female parts: When the pistils or female parts have no stalk or filament like the stamina, they are numbered by the stigmata or tops of the pistils, which in that case adhere to the capsule in the form of small protuberances, as may be observed in the flowers of the poppy, &c.

The orders of the 14th class are derived from a different source. The plants belonging to it have their seeds either inclosed in a capsule, or altogether uncovered. Hence they naturally admit of a division into the following orders, *viz.* *gymnospermia*, comprehending such as have naked seeds; and *angiospermia*, which comprehends such as have their seeds covered, or inclosed in a capsule.

The 15th class is divided into two orders, *viz.* the *siliculosa*, or those which have a short siliqua or pod; and the *siliquosa*, or those which have a longer siliqua.

The orders of the 16th, 17th, 18th, and 20th classes, are taken from the number of stamina, *e. g.* monodelphia pentandria, decandria, polyandria, &c.

The SYNGENESIA, or 19th class, consists of plants whose flowers are compounded of a great number of small flowers or floscules inclosed in one common calix. The orders of this class are,

*Polygamia aequalis*, or such whose floscules are all furnished with stamina and pistils.

*Polygamia spuria*, comprehends those which have hermaphrodite floscules in the disk, and female floscules in the margin. This circumstance is made the foundation of the three following orders. 1. *Polygamia superflua*, includes all those whose hermaphrodite flowers in the

disk are furnished with stigmata, and bear seed; and whose female flowers in the radius likewise produce seeds. 2. *Polygamia frustranea*, include such as have hermaphrodite seed-bearing floscules in the disk; but whose floscules in the radius, having no stigmata, are barren. 3. *Polygamia necessaria*, is the reverse of the former: The hermaphrodite flowers in the disk want stigmata, and are barren; but the female floscules in the radius are furnished with stigmata, and produce seeds.

*Polygamia segregata*, many floscules inclosed in one common calix, and each of the floscules likewise furnished with a perianthium proper to itself.

*Monogamia*, this order consists only of seven genera, *viz.* the strumphia, seriphium, corymbium, jassione, lobelia, viola, and impatiens; none of which have properly compound flowers, but are ranked under this class purely from the circumstance of having their stamina united by the antheræ.

The orders of the 21st class are partly taken from the number of stamina, and partly from the names and characters peculiar to some of the other classes, *e. g.* monœcia triandria, monœcia syngenesia, monœcia gynandria.

The orders of the 23d are all taken from classical characters, *e. g.* polygamia monœcia, polygamia diœcia, and polygamia triœcia.

The 24th, or CRYPTOGAMIA class, is divided into the four following orders: 1. *Filices*, comprehending all plants that bear their seed in the back or edges of the leaf, and those that are called *capillary plants*. 2. *Musci*, which comprehends all the moss kind. 3. *Algae*, including the lichens, fuci, and many others whose parts of fructification are either altogether invisible or exceedingly obscure. 4. *Fungi*, comprehending all the mushroom tribe.

Having thus explained the method of reducing plants to their classes and orders, we shall proceed to inform the young botanist how to investigate the genus. This depends upon minuter distinctions, and requires more attention. But it is impossible to investigate the genera, without being previously acquainted with a considerable number of terms. All the terms necessary for this purpose belong to the parts of fructification. To attempt to give an idea by words of the parts to which particular terms are applied, would not only be difficult, but, in a great measure, useless, especially to such as are totally ignorant of botany. We shall therefore give a list of the terms themselves, with proper references to the figures of the things signified by them, which will both be shorter, and more intelligible than the most accurate description that language is capable of.

#### List of Terms belonging to the Flowers and Parts of Fructification. See Plate LIV.

- FIG. 1. *Spatha*, a species of calix opening longitudinally when the flower breaks through it.  
2. *Spadix*, a species of receptacle peculiar to palm-trees, which consists of fruit-bearing branches included in a spatha.





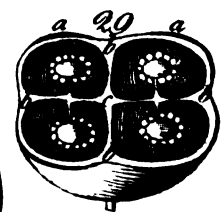
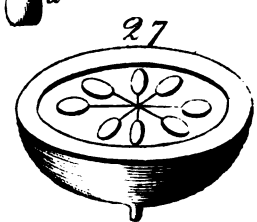
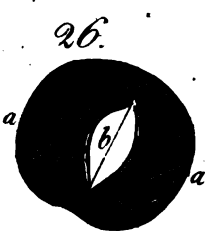
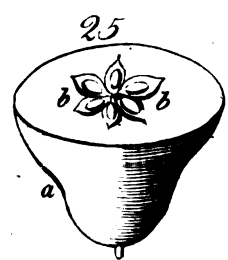
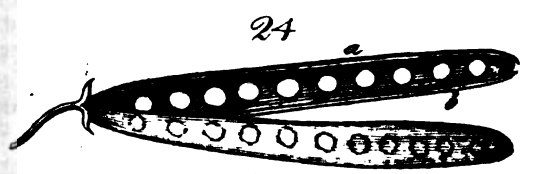
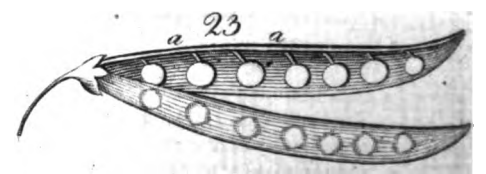
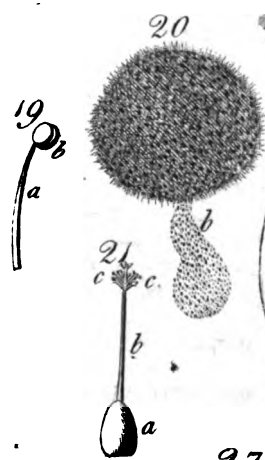
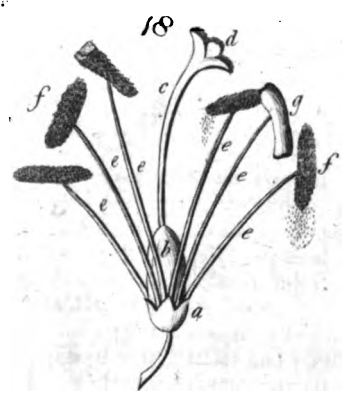
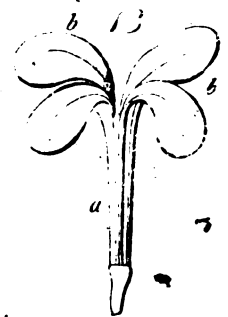
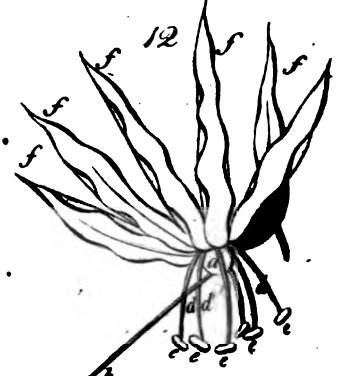
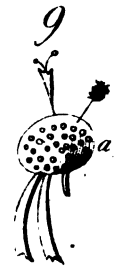
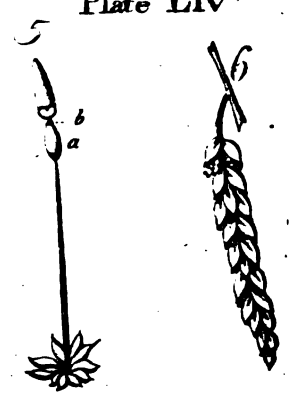
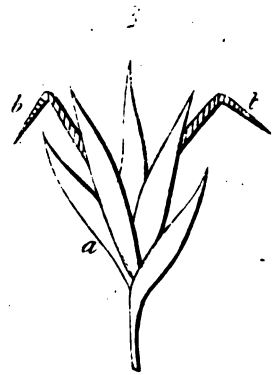


Fig.

3. a, *Gluma*, another species of calix, belonging chiefly to grasses and corns, and consists of different valves; b, *arista*, or awn.
4. a a, *Umbella universalis*, comprehends the whole flowers, &c. arising from a common centre, and resembling a large fan. b, *Umbella partialis*, or a smaller parcel of the flowers, &c. resembling a small fan. c c, *Involucrum universale*, a species of calix in which the whole flowers were inclosed before their blowing. d d, *Involucrum parziale*, a lesser calix, which includes a smaller bundle of flowers, and which, before their blowing, is inclosed in the involucrum universale. Examples of these are found in the hemlock, carrot, &c.
5. c, *Galyptra*; b, *operculum*; a, *capitulum*. These terms are peculiar to mosses.
6. *Amentum*, a species of calix, e. g. in the willow, birch-tree, &c.
7. *Strobilus*, a pericarpium or capsule composed of an amentum, an example of which occurs in the magnolia.
8. *Fungi*. a, *Pileus*; b, *volva*; c, *stipes*. These two are mostly applied to the parts of mushrooms.
9. a, *Receptaculum commune nudum*, the common receptacle, or base of the flower, when the stamina, pistil, capsule, &c. are taken off.
10. *Receptaculum commune paleis imbricatum*, or common receptacle imbricated or tiled with paleæ, or membranaceous lamellæ.
11. *Corollæ monopetale*. a, *Tubus*; b, *limbus*; i. e. a, the tube; b, the edge or margin of a monopetalous corolla. The corolla signifies the flower-leaf, when it consists but of one, and the whole flower-leaves, when it consists of more.
12. Is a flower laid in a proper position for shewing its different parts. a, *Germen*, which includes the seeds and capsule in which they are inclosed; b, *stylus*, which is a continuation of the germen; c, *stigma*, or top of the stylus; d d d d d, *filamenta*, or threads; e e e e e, *antheræ*. The filamenta and antheræ, considered as a whole, are called *stamina*; and the germen, stylus, and stigma, as a whole, are called *pistillum*. f f f f f, *Petala*, or flower-leaves.
13. a, The *ungues*, or claws; b, the *laminae*, or plates of a polypetalous corolla, or corolla consisting of several flower-leaves.
14. a, *Nectarium campanulatum in narcissa*, or bell-shaped nectarium of the narcissus. Nectarium is applied to every glandular part of a flower which secretes a sweet juice. Their structure is very different in different plants.
15. *Nectaria cornuta in aconita*, horned nectaria of the monkhood.
16. *Horned nectarium* in the calix of the tropæolus.
17. a a a a, *Nectarium in parnassia*; the nectaria of the parnassia grass are six in number, each of which have thirteen styli, with round buttons on their tops.
18. a, *Perianthium*, that species of calix which is contiguous to the fructification; b, *germen*; c, *stylus*; d, *stigma*; e e, *filamenta*; f f, *antheræ dehiscentes*, or antheræ shedding the pollen or dust; g, *anthera*

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3

Fig.

- integra*, i. e. the appearance of the anthera before it sheds the pollen.
19. a, The *filament*, and b, the *anthera*, separated from the flower.
  20. a, One grain of the *pollen* magnified by a microscope; b, *halitus elasticus*, i. e. an elastic aura supposed to be necessary for impregnating the seeds.
  21. a, *Germen*; b, *stylus*; c c, *stigma*.
  22. *Folliculus*, i. e. a pericarpium consisting only of one valve, opening longitudinally, and in which the seeds do not adhere to the future, but are inclosed in a particular receptacle a.
  23. *Legumen*, is a double-valved pericarpium, having the seeds fixed only to one of the futures a a.
  24. *Siliqua*, is a double-valved pericarpium with the seeds fixed to both futures or margins a b.
  25. *Pomum*, a pericarpium without any valve, but made up of a pulpy substance, and containing a capsule in which the seeds are inclosed, as in the apple, &c. a, The *pericarpium*; b, the *capsule*, or seed-case.
  26. a, *Drupa*, or a pericarpium containing a nut or stone, and having no valve, e. g. plumbs, &c. b, the *nucleus*, or stone.
  27. *Bacca*, or berry, is a pericarpium containing naked seeds dispersed through the pulpy part.
  28. *Capsula apice dehiscentis*, a capsule opening at the top to allow the seeds to fall out.
  29. Four capsules included in a common pericarpium. a a, The valves; b b, the dissepimentum, or partition which separates the different seed-capsules from one another; c, columella, or central column by which the capsules are connected.
  30. A capsule cut open longitudinally, to show the receptacle of the seeds.
  31. *Pappus*, a kind of corona or crown which is either hairy or penniform, and connected to the seeds of some plants, by means of which they are blown about by the wind. a, *Pappus pilosus*, or pappus resembling a hair; b, *pappus plumosus*, or feathered pappus; c, *semen*; d, *stipes*. The dandelion, and many plants of the syngenesia class, afford examples of these parts.

*Terms belonging to the Pedunculus or Foot-stalks of Flowers.*

32. *Corymbus*, i. e. flowers upon alternate pedunculi and foot-stalks, elevated proportionally above each other.
33. *Racemus*, a pedunculus or foot-stalk furnished with lateral branches.
34. *Spica*, alternate sessile flowers [i. e. flowers without any particular foot-stalk, but inserted directly into one common to the whole], upon a common foot-stalk, as in the scirpus.
35. *Verticillus*. This term is applied to such plants as have clusters of flowers at different distances surrounding the caulis or stem; as in several species of mint.
36. *Panicula*, i. e. flowers placed sparsely upon separate foot-stalks, as in oats, &c.

When these terms are understood, the genus may be easily investigated. But in order still further to assist the young botanist, we shall give a systematic description of a few common plants belonging to different classes.

†

7 Y

DIAN-

## DIANDRIA MONOGYNIA.

## VERONICA, or SPEEDWELL.

The CALIX is a perianthium (18), divided into four parts or segments, and persistent (i. e. does not fall off till the seeds are ripe); the segments are sharp and lance-shaped.

The COROLLA (11) consists of one rotated petal; The *tubus* (11) is about the same length with the calix; the *limbus* (11) is plane, and divided in four oval segments, the lowest of which is narrower than the rest, and the one immediately opposite broader.

The STAMINA (12) are two, narrower below, and inclined upwards; the antheræ (12) are oblong.

The PISTILLUM (12) has a compressed germen (12), a filiform or thread-like stylus (12), about the same length with the stamina, and a little declined to one side: The stigma (12) is simple.

The PERICARPIUM (12) is a heart-shaped capsule, compressed at the top, and having two cells or partitions, and four valves.

The SEEDS are roundish and numerous.

## ICOSANDRIA POLYGAMIA.

## FRAGARIA, or STRAWBERRY.

The CALIX is a perianthium, consisting of one plain leaf, divided into ten segments, each alternately narrower.

The COROLLA has five roundish open petals inserted into the calix.

The STAMINA are twenty in number, subulated or tapering, shorter than the corolla, and inserted into the calix. The antheræ are lunulated, or shaped like a crescent.

The PISTILLUM consists of many small germina, collected into a little head or knob. The styli are simple, and inserted into the sides of their respective germina. The stigmata are simple.

The PERICARPIUM is wanting in this plant. But the common receptacle of the seeds, which supplies the place of a pericarpium, is a roundish oval berry, plain at the base, pretty large, soft, pulpy, coloured, and deciduous, i. e. falls off before the seeds be ripe.

The SEEDS are small, pointed, very numerous, and dispersed through the superficial part of the receptacle.

## DIDYNAMIA ANGIOSPERMIA.

## DIGITALIS, or FOX-GLOVE.

The CALIX is a perianthium, divided into four deep out segments, which are roundish, sharp at the top, persistent, and the highest one is narrower than the rest.

The COROLLA consists of one bell-shaped petal; the *tubus* is large, open, ventricose or bellied at the back-side; the base is cylindrical and narrow: The *limbus* is small, and divided into four segments; the superior segment is more open and more emarginated than the rest.

The STAMINA are four, subulated (44), inserted into the base of the corolla, and inclined to the same side; two of them are longer than the other two: The antheræ are divided into two parts, and pointed at the top.

The PISTILLUM consists of a germen sharp at the top, a simple stylus situate like the stamina, and an acute stigma.

The PERICARPIUM has an oval capsule, of the same length with the calix, sharp at the top, having two cells, and two valves which burst open at both sides.

The SEEDS are many and small.

## TETRADYNAMIA SILIQUOSA.

## SINAPIS, or MUSTARD.

The CALIX is a perianthium consisting of four open or spreading leaves; the leaves are linear (43), concave, furrowed, disposed in the form of a cross, and deciduous.

The COROLLA consists of four cruciform petals: The petals are roundish, plain, open, entire or not emarginated, with erect linear unguis (13) scarcely so long as the calix.

The NECTARIA (14, &c.), or *glandula nectarifera*, are four, of an oval figure, one of which is situate on each side betwixt the short stamina and stylus, and likewise one on each side between the long stamina and the calix.

The STAMINA have six subulated, erect filaments, two of which are of the same length with the calix, and always opposite to each other, and the other four are uniformly longer: The antheræ are erect, and sharp at the top.

The PISTILLUM has a cylindrical germen; the stylus is of the same length with the germen, and the same height with the stamina; the stigma is entire, with a little knob or button.

The PERICARPIUM is an oblong, scabrous, double-celled, two-valved pod, gibbous, and full of little protuberances on the under parts: The dissepimentum (29) is large, compressed, and often twice the length of the valves.

The SEEDS are many and round.

## MONODELPHIA POLYANDRIA.

## MALVA, or COMMON MALLOW.

The CALIX is a double perianthium: The exterior one consists of three lanceolated, loose, persistent leaves; the interior has but one large, broad, persistent leaf, divided into five segments.

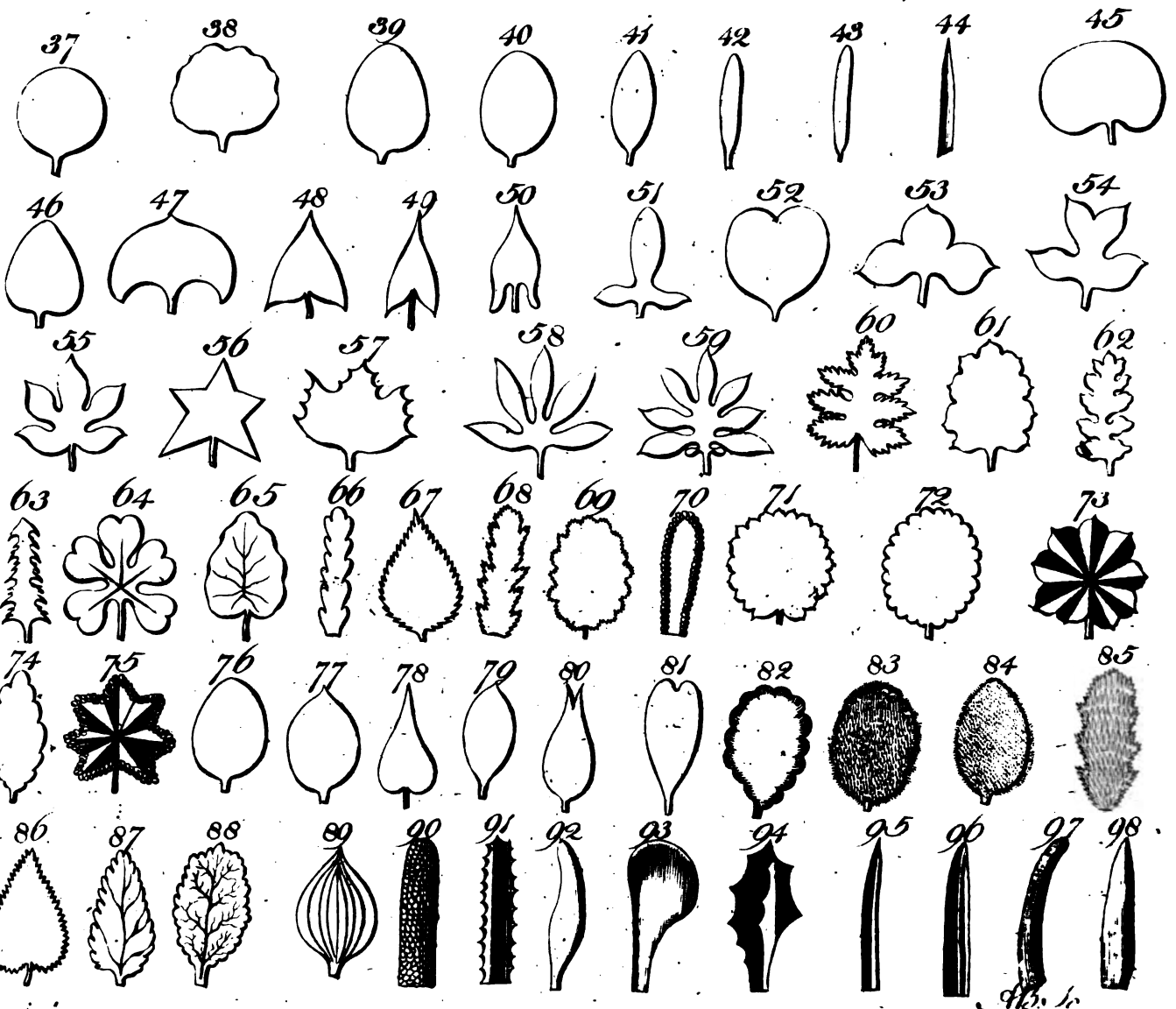
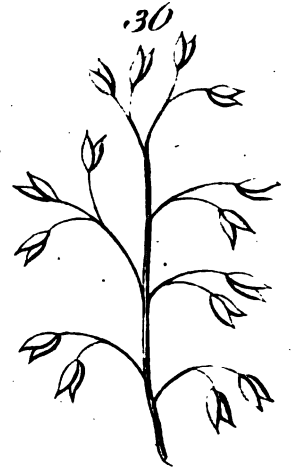
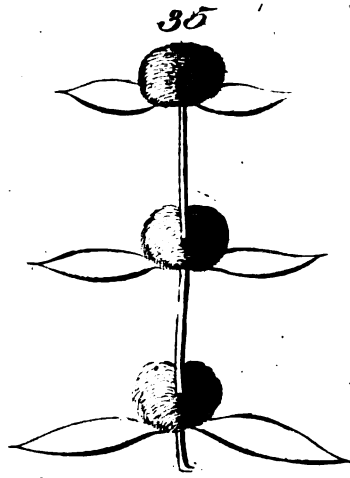
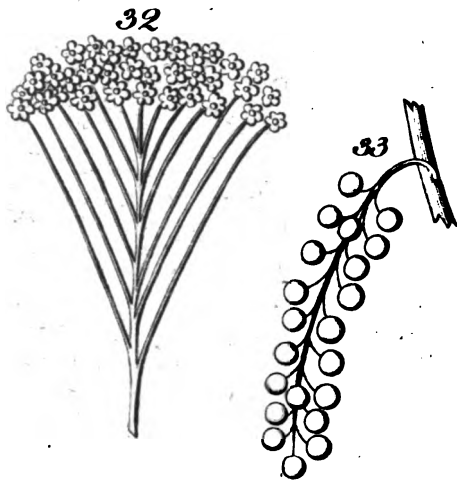
The COROLLA has five plain leaves, united at the base, heart-shaped, and premorse (54).

The STAMINA consist of numerous filaments, united into a cylindrical form below, loose above, and inserted into the corolla: The antheræ are kidney-shaped.

The PISTILLUM has an orbicular germen, a cylindrical, short stylus, and many bristly stigmata of an equal length with the stylus.

The PERICARPIUM consists of several distinct capsules joined by an articulation, resembling a depressed globe, and





Tab. 10

and opening from within when ripe: The receptaculum is a kind of column binding the capsules together.

The SEEDS are solitary, and kidney-shaped.

**SYNGENESIA POLYGAMIA AEQUALIS.**

**LEONTÖDON, or DANDELION.**

The common CALIX is oblong, and imbricated: The interior scales are linear, parallel, equal, and open at the top; the exterior scales are fewer in number, and frequently reflected at the base.

The compound COROLLA is uniform and imbricated.

The small hermaphrodite corollæ are very numerous and equal.

The corolla proper to each floscule consists of one ligulated (*i. e.* plain and expanded outwards), linear, truncated (*i. e.* terminated by a transverse line), and five-toothed petal.

The STAMINA consist of five very small capillary filaments: The antheræ are connected together, and form a cylindrical tube.

The GERMEN of the pistillum is situate below the proper corolla. The stylus is filiforme, and nearly of the same length with the corolla: The stigmata are two, and turned back in a spiral form.

This plant has no pericarpium.

The SEEDS are solitary, oblong, rough, and terminated by a long pappous stipes (31).

The receptacle, or common base of the floscules (9), is naked, and full of small hollow points.

**GYNANDRIA PENTANDRIA.**

**PASSIFLORA, or PASSION-FLOWER.**

The CALIX is a perianthium consisting of five plain, coloured leaves, similar to those of the corolla.

The COROLLA consists of five plain obtuse semi-lanceolated leaves, of the same magnitude and figure with those of the calix.

The nectarium is a triple corona, the exterior of which is longest, surrounding the stylus within the petals, and straitened above.

The STAMINA are five, subulated, open, and connected to the stylus at the base of the germen: The antheræ are oblong, obtuse, and incumbent.

The PISTILLUM consists of an erect cylindrical stylus, upon the top of which an oval germen is placed: The styli are three, thicker, and wider above: The stigmata are roundish knobs.

The PERICARRIUM is a fleshy, suboval, one-celled berry, resting upon the stylus.

The SEEDS are numerous, oval, and each of them inclosed in a small membrane.

**MONOECIA TETRANDRIA.**

**URTICA, or COMMON NETTLE.**

The CALIX of the male flowers is a four-leaved perianthium; the leaves are roundish, concave, and obtuse.

The COROLLA has no petals; but there is a small urceolated (*i. e.* an inflated skin, gibbous on each side) nectarium in the centre of the flower.

The STAMINA consists of four subulated open filaments, of an equal length with the calix, and one of them is placed between each leaf of the calix: The antheræ have no cells.

The CALIX of the female flowers is a double-valved, oval, concave, erect, persistent perianthium.

The COROLLA is wanting.

The PISTILLUM has an oval germen, no stylus, and a downy stigma.

They have no pericarpium.

The SEED is single, oval, shining, and a little compressed.

These examples will not only illustrate most of the generic terms, but will likewise fix them in the mind more successfully than any formal explanation. A careful perusal of them will enable any person to understand the descriptions in the *Genera Plantarum* of Linnæus, although he should not be much acquainted with the Latin language.

But the young botanist, after advancing this far, must still be conducted a step further. Though he may be able to reduce plants to their classes, orders, and genera, he is hitherto totally ignorant of the specific characters. Before he be able to investigate the species, he must again submit to learn a considerable number of terms necessary for that purpose.

*List of Terms necessary for investigating the Species of Plants.*

**SIMPLE LEAVES.**

Fig.

- 37. *Orbiculatum*, globular.
- 38. *Subrotundum*, roundish.
- 39. *Ovatum*, shaped like an egg.
- 40. *Ovale*, oval or elliptical.
- 41. *Oblongum*, oblong.
- 42. *Lanceolatum*, in the form of a dart, or tapering on each side to a point.
- 43. *Lineare*, like a line, or of the same breadth and thickness throughout.
- 44. *Subulatum*, tapering to a point, like an awl.
- 45. *Reniforme*, shaped like a kidney.
- 46. *Cordatum*, like a heart.
- 47. *Lunulatum*, resembling a crescent or half-moon.
- 48. *Triangulare*, three-cornered.
- 49. *Sagittatum*, like an arrow.
- 50. *Cordato-sagittatum*, resembling both a heart and an arrow.
- 51. *Hastatum*, like a spear or lance.
- 52. *Fissum*, cut in at the top.
- 53. *Tribolum*, consisting of three (55) lobes.
- 54. *Prænorsum*, *i. e.* as if a piece were bit out of the fore-part of the leaf.
- 55. *Lobatum*, consisting of lobes, or segments cut to the middle of the leaf, and convex at the edges.
- 56. *Quinangulare*, consisting of five angles.

57, *Erosum*.

Fig.

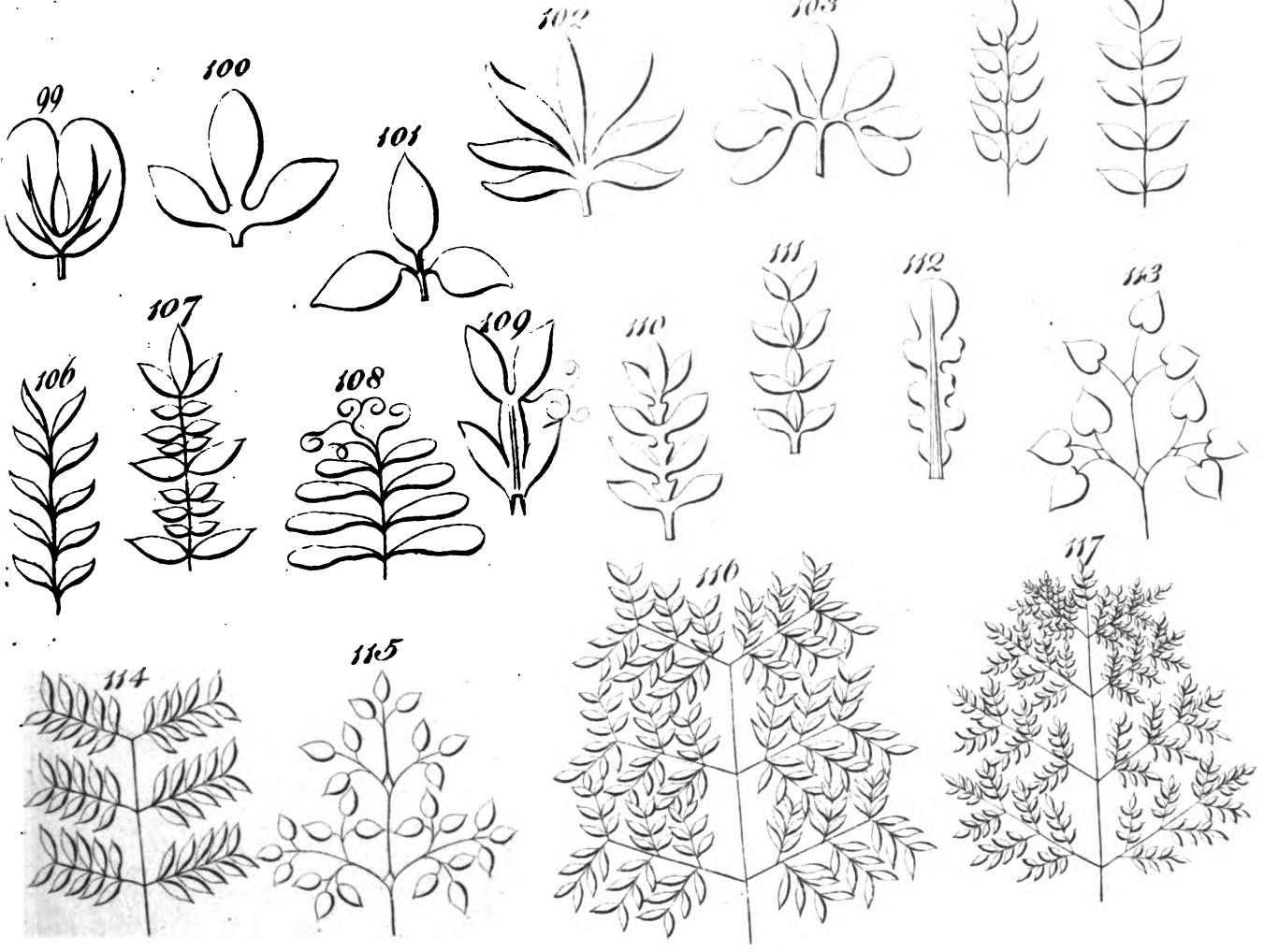
57. *Erosum*, as if eroded or eat irregularly by some corrosive substance.
58. *Palmatum*, resembling a hand.
59. *Pinnatum*, divided into pieces resembling fins.
60. *Laciniatum*, with many cuts or indentures in the margin.
61. *Sinuatim*, having wide sinuses or hollows in the margin.
62. *Dentato-sinuatum*, having sinuses and divisions resembling teeth.
63. *Retrorsum sinuatum*, hollowed and bent backwards.
64. *Partitum*, when the divisions or segments reach near the base of the leaf.
65. *Repandum*, a waving but undivided margin.
66. *Dentatum*, toothed, *i. e.* when the tops of the segments are remote from each other.
67. *Serratum*, when the segments uniformly incline to the extremity.
68. *Duplicato-serratum*, doubly serrated, *i. e.* when the lesser segments incline to the extremities of the larger ones.
69. *Duplicato-crenatum*, doubly crenated, (74)
70. *Cartilagineum*, when the margin of the leaf has a cartilaginous or gristly texture.
71. *Acute-crenatum*, sharp segments having no determinate inclination to either extremity.
72. *Obtuse-crenatum*, the same with the above, only the segments are blunt.
73. *Plicatum*, plaited, or consisting of regular folds.
74. *Crenatum*, segments having no inclination to either extremity.
75. *Crispum*, when the margin is larger than the disc, and formed into a kind of waves,
76. *Obtusum*, blunt at the top.
77. *Acutum*, sharp, or pointed.
78. *Acuminatum*, when the leaf tapers to a sharp point at the top.
79. *Obtusum acumine*, having a short subulated point.
80. *Emarginatum acute*, having sharp divisions at the top of the leaf.
81. *Unciforme marginatum*, having wedge-shaped divisions at the top.
82. *Retusum*, having blunt sinuses.
83. *Pilosum*, covered with long distinct hairs.
84. *Tomentosum*, interwoven with soft hairs, and often of a white colour.
85. *Hispidum*, having brittle rough bristles diffusely scattered upon the disc of the leaf.
86. *Ciliatum*, having parallel bristles round the margin.
87. *Rugosum*, full of rugæ or wrinkles.
88. *Venosum*, having veins or nerves consisting of many ramifications.
89. *Nervosum*, when the veins or nerves are extended from the base to the top without any branches.
90. *Papillosum*, covered with vesicles, bladders, or hollow points.
91. *Linguiforme*, like a tongue, *i. e.* fleshy, linear, obtuse, convex below, and having frequently a cartilaginous margin.
92. *Acinaciforme*, resembling a kernel;—compressed,

Fig.

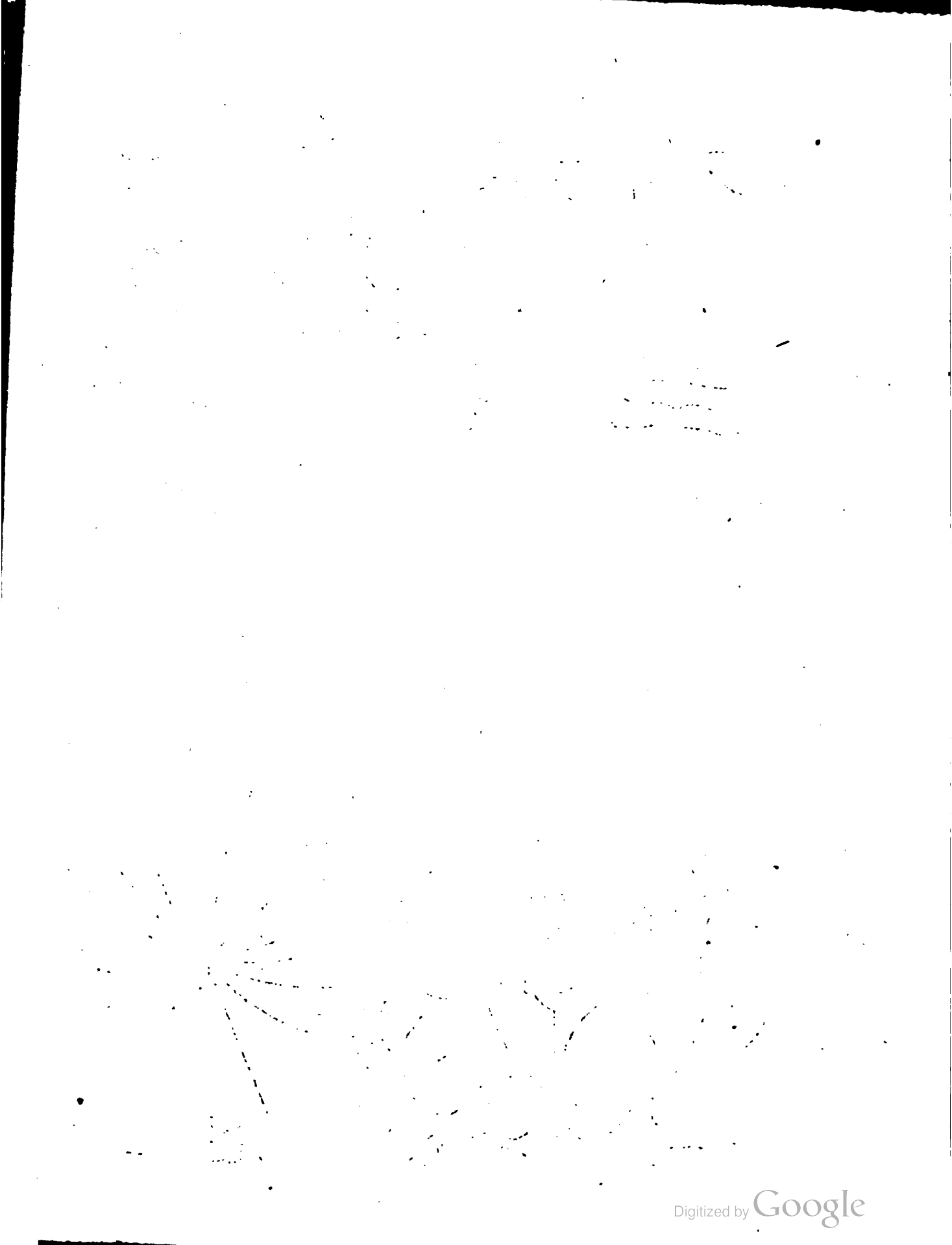
- fleshy, having one edge narrow and convex, and the other thicker and more straight.
93. *Dolabriforme*, resembling an ax;—compressed, roundish, gibbous on the outside, with a sharp edge, which is a little blunter below.
94. *Deltoides*, an irregular rhomboidal figure. See the leaf of the black poplar.
95. *Triquetrum*, having three plain sides.
96. *Canaliculatum*, having a deep longitudinal furrow.
97. *Sulcatum*, having several deep furrows.
98. *Teres*, cylindrical, or like a cylinder.
99. *Binatum*, when a simple petiolus has two leaves connected to its apex.
100. *Ternatum foliis sessilibus*, three sessile leaves (*i. e.* having no petioli) connected to one common petiolus.
101. *Ternatum foliolis petiolatis*, three leaves upon a common petiolus, each having at the same time a separate petiolus.
102. *Digitatum*, or resembling fingers, *i. e.* when a simple petiolus has two, three, four, or more leaves connected to its apex.
103. *Pedatum*, a bifid or forked petiolus, having small leaves connected to its interior side.
104. *Pinnatum cum impari*; small leaves connected to the sides of a simple petiolus, terminated by an odd leaf.
105. *Pinnatum abruptum*, neither terminated by an odd leaf nor a cirrhus.
106. ——— *alternatum*, when the small leaves rise higher and higher alternately upon the petiolus.
107. ——— *interrupta*, when the pinnated leaves are alternately larger and smaller.
108. ——— *cirrhosum*, when the common petiolus ends in a cirrhus.
109. ——— *conjugatum*, when the common petiolus has only two leaves connected.
110. ——— *decurfive*, when the small leaves run along the petiolus.
111. ——— *articulate*, when the common petiolus is jointed.
112. *Lyratum*, like a harp, *i. e.* when the leaf is transversely divided into segments, the superior of which are larger than the inferior, and the inferior ones are more distant from each other.
113. *Biternatum*, or *duplicato-ternatum*, when the common petiolus has three ternated (100) leaves fixed to it. The epimedium is an example of this.
114. *Bipinnatum*, or *duplicato-pinnatum*, when the common petiolus gives off pinnated (104) petioli from its sides.
115. *Triternatum*, or *triplicato-ternatum*, when the common petiolus sends off from its sides three biternated (113) leaves.
116. *Tripinnatum sine impari*, when the common petiolus has three or more bipinnated (114) leaves fixed to its sides, not terminated by a single leaf.
117. ——— *cum impari*, the same with the former, only terminated by a single leaf.

Termin

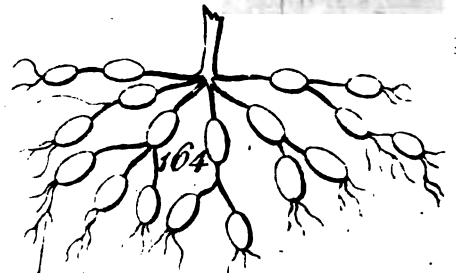
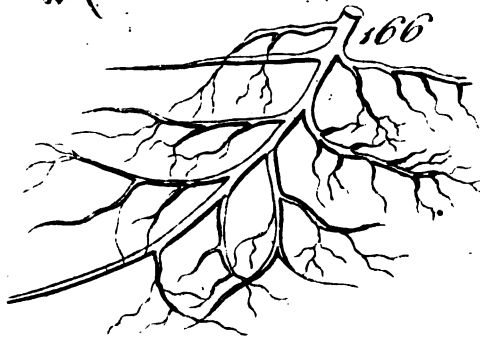
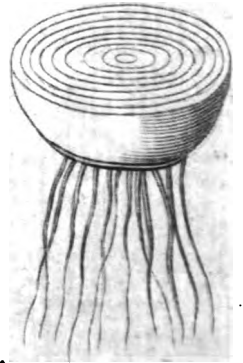
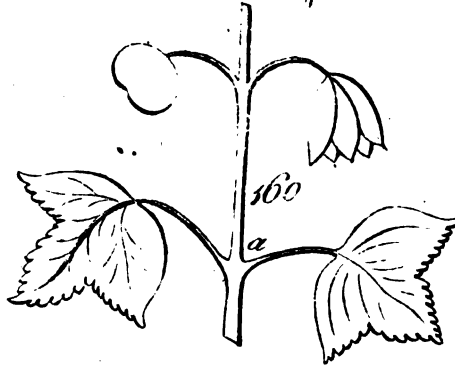
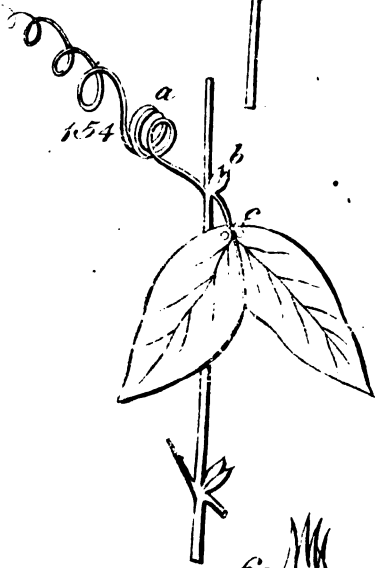
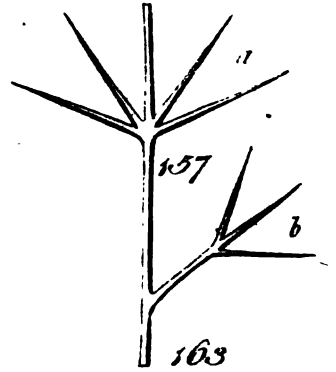
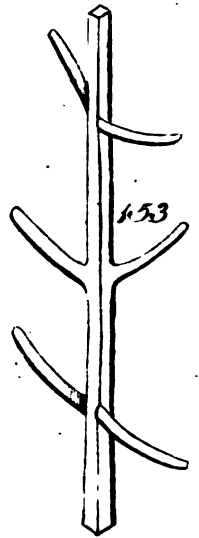
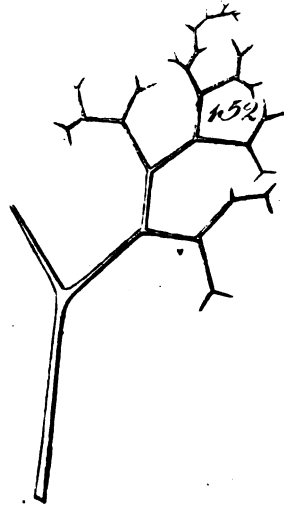
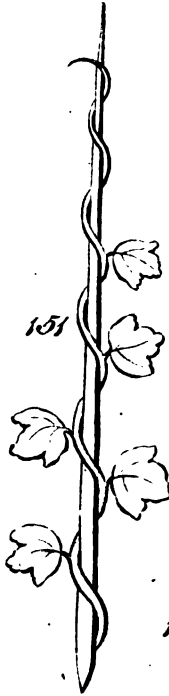
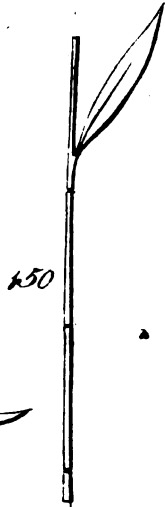
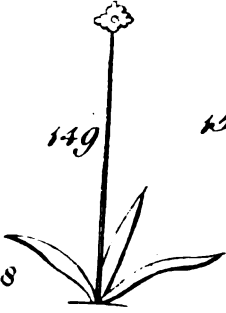




Bell & Sculp







*Terms respecting the Determination of Leaves.*

Fig.

- 118. *Inflexum*, when the leaves bend or arch upwards upon the caulis or stem.
- 119. *Erectum*, when the leaves make a very acute angle with the caulis.
- 120. *Patens*. This term is applied to leaves which make a more obtuse angle with the caulis than the former.
- 121. *Horizontale*, when the leaves stand at right angles with the caulis.
- 122. *Raclinatum*, or *reflexum*, when the leaf bends down, so that the apex is lower than the base.
- 123. *Revolutum*, when both sides of the leaf are rolled backwards in a spiral form.
- 124. *Seminale*, seed-leaves, or dissimilar leaves. They are the lobes of the seed, which in many plants arise entirely out of the ground, and are always the first that appear above the surface. See AGRICULTURE, p. 41.
- 125. *Caulinum*, such as arise immediately from the caulis or stem.
- 126. *Rameum*, such as arise from a branch of the caulis.
- 127. *Florale*, such as arise from the same place with the flower.
- 128. *Peltatum*, when the petiolus is inserted, not into the edge or base, but into the disk of the leaf.
- 129. *Petiolatum*, when the petiolus is inserted into the margin of the base.
- 130. *Sessile*, when the leaf has no petiolus, but is immediately connected to the caulis.
- 131. *Decurrens*, when the base of a sessile (130) leaf is extended downwards along the caulis; as in the verbascina, carduus, &c.
- 132. *Amplexicaule*, when the base of the leaf embraces the caulis on all sides.
- 133. *Perfoliatum*, when the base of the leaf entirely surrounds the caulis, so that the caulis seems to perforate the leaf.
- 134. *Comatum*, when the opposite leaves run into one another, and surround the caulis, as in the eupatorium.
- 135. *Vaginans*, when the base of the leaf forms a cylindrical tube investing the caulis.
- 136. *Articulatum*, in the form of joints, *i. e.* when one leaf arises from the apex of another.
- 137. *Stellata*, radiated like a star, *i. e.* when more than two leaves surround a verticillated (35) caulis.
- 138. *Quaterna, quina, sena, &c.* are species of stellated (137) leaves, when there are four, five, or six, &c. leaves surrounding the caulis.
- 139. *Opposita*, when the leaves of the caulis are exactly opposite to one another.
- 140. *Alterna*, when the leaves rise alternately higher upon the caulis.
- 141. *Acerosa*, linear, persistent leaves, as in the pinus or fir-tree, &c.

Fig.

- 142. *Imbricata*, when the leaves rest upon one another like tiles on a roof.
- 143. *Fasciculata*, when many leaves rise from the same point, as in the larynx.
- 144. *Frons*. This term is applied to a species of trunk, which consists of branches and leaves, and sometimes the fructification, all united together: It is peculiar to the filices, or ferns, and the palmæ.
- 145. *Spatulatum folium*, is a roundish leaf, with a narrow linear base.
- 146. *Parabolicum folium*, like a parabola, *i. e.* having its longitudinal diameter longer than the transverse, and growing narrower from the base till it terminates in an oval figure.

*Terms relating to the Caules or stems. Plate LVII.*

- 147. *Squamosus culmus*. The *culmus* is a trunk or stem peculiar to grasses; and *squamosus culmus* is a scaly culmus.
- 148. *Repens caulis*. The *caulis* or stem is a species of trunk peculiar to herbaceous plants, and supports the leaves or parts of fructification: *Repens caulis* is a stem which gives out small roots on every side, as it runs along the surface of the ground, or upon another plant.
- 149. *Scapus*, is a species of trunk which supports the parts of fructification, but has no leaves.
- 150. *Articulatus culmus*, a culmus (147) with many joints.
- 151. *Volubilis caulis*, a caulis (148) which runs in a spiral form upon the trunk or branch of another plant, &c.
- 152. *Dichotomus caulis*, a caulis (145) uniformly dividing into branches.
- 153. *Brachiatus caulis*, a caulis having opposite decussating branches, resembling arms.

*Terms relating to the Fulcra or supports of Leaves.*

- 154. a, *Cirrus*, a spiral thread which connects the plant to any other body. b, *Stipula*, or little scales at the base of the petiolus or pedunculus. c, *Glandula concava*, small hollow glands for secreting a liquor.
- 155. a, *Glandula pedicellata*, small glands, each supported by a pedunculus.
- 156. a, *Bractea*, or flower-leaf, which differs in shape from the other leaves of the plant b.
- 157. a, *Spina simplex*, a simple thorn or prickle. b, *Spina triplex*, or three prickles proceeding from one. *Spina* is applied to such thorns as are protruded from the wood of the plant.
- 158. *Aculeus simplex*. *Aculeus* is a prickle not protruded from the wood, but only fixed to the bark. It is said to be *simplex*, when it rises single.
- 159. *Aculeus triplex*, a triple aculeus (158).
- 160. *Opposita folia*, or opposite leaves. a, The *axilla* or ar-pit.

*Terms relating to Roots.*

Fig.

161. *Bulbus squamosus*, when the root is composed of imbricated or tiled scales or plates, as in the lily-root.
162. *Bulbus solidus*, consisting of a solid substance.
163. *Bulbus tunicatus*, consisting of coats lying above one another, as in the onion.
164. *Tuberosa radix*, a root consisting of a great many little knots, as in the filipendula.
165. *Fusiformis radix*; like a spindle, *i. e.* oblong, thick, and tapering to a point below, as in the root of the carrot.
166. *Ramosa radix*, having many lateral branches.
167. *Repens radix*, a root which creeps horizontally, and sends off every where smaller roots at different distances.

THESE are the principal terms necessary for understanding Linnæus's description of the specific characters of plants.—To make the reader acquainted with the manner in which these terms are used, we shall give a few examples.

## Class II. DIANDRIA.

Order, MONOGYNIA.

Genus, VERONICA, or SPEEDWELL.

Species, *Veronica arvensis*, has solitary flowers, cut, sessile (130), and cordated (46) leaves.*Veronica agrestis*, has solitary flowers, cut, cordated (46), and petiolated (129) leaves.

## Class XVI. MONODELPHIA.

Order, POLYGYNIA.

Genus, MALVA, or MALLOW.

Species, *Malva spicata*, has tomentose (84), crenated (74), and cordated (46) leaves, and oblong hairy spicæ (34).*Malva sylvestris*, has an erect (119) herbaceous caulis (148), with acute (74), seven-lobed (50) leaves, and hairy pedunculi and petioli (129).

## Class XIX. SYNGENESIA.

Order, POLYGAMIA ÆQUALIS.

Genus, CARDUUS, or THISTLE.

Species, *Carduus helenioides*, or *melancholy thistle*, has lanceolated (42), teetted (66), amplexicaule (132) leaves, with unequal ciliated (86) small spines (158).

## Class XXIV. CRYPTOGAMIA.

Order, FILICES.

Genus, ASPLENIUM, or MAIDENHAIR.

Species, *Asplenium trichomanes*, has a pinnated (104) frons (144); the pinnæ (104) are roundish (38) and crenated (74).

To these examples we shall add a complete description of a plant reduced to its class, order, genus, and species, with figures of all the parts necessary for that purpose.

## RHEUM PALMATUM, or True Rhubarb. See Plate LVIII.

The flower of this plant has no CALIX.

The COROLLA *dd*, consists of one petal, narrower at the base, not perforated, and divided in the margin into six obtuse segments, one less and one larger alternately; the petal is marcescent, *i. e.* decays, but does not fall off till the seeds be ripe.The STAMINA *ee*, consist of nine capillary filaments inserted into the corolla, and about the same length with it. The *anthera* are didymous, (*i. e.* appear to be double), oblong, and obtuse.The PISTILLUM *f*, has a short three-sided germen. It can hardly be said to have any styli; but has three retracted, plumose stigmata.

The PERICARPIUM is wanting.

Each flower contains but one large, three-sided, acute seed *g*, with a membranaceous edge.

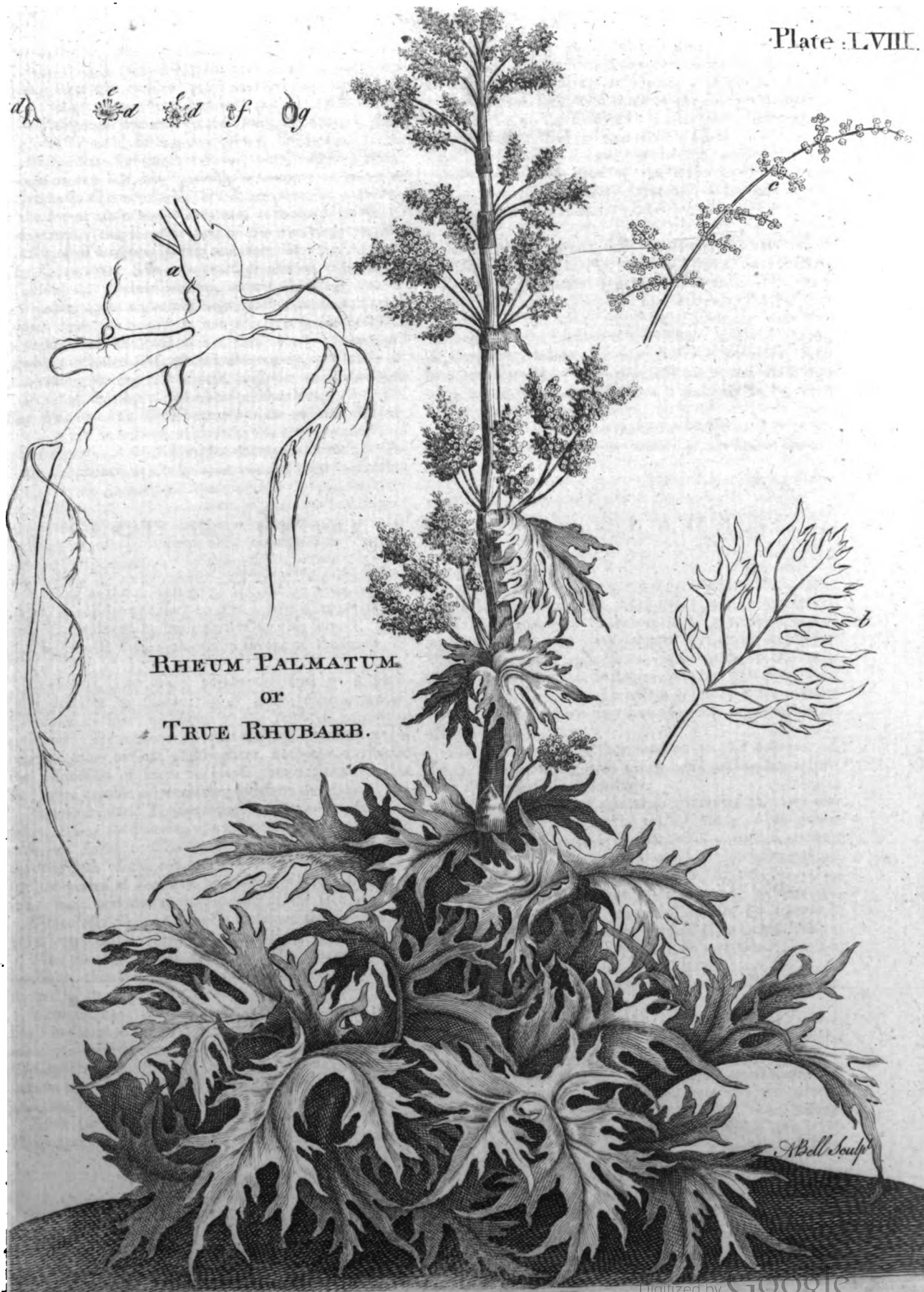
The number of stamina determines this plant to belong to the ENNEANDRIA class; and the number of STIGMATA fixes its order to be TRIGYNIA. The other parts of the above description clearly demonstrate the genus to be the Rheum or Rubarb, and sufficiently distinguish it from the Laurus, Tinus, Cassya, and Butomus, the only other genera belonging to this class.

The SPECIFIC mark is taken from the leaves, which are PALMATED (58), and sharp and tapering at the points. There are but five species of Rheum, none of whose leaves are palmated, except the species now described.

But though the above description be sufficient for ascertaining the genus and species of this valuable plant, there are other reasons for giving a complete botanical description of the whole parts of it. The true rhubarb, though of the most extensive use in medicine, was never known in this country till the year 1762, when Dr Moutfey brought some seeds from Russia, and gave them to Dr Hope professor of medicine and botany in Edinburgh. Dr Hope sowed them in the botanical garden, and collected about 30 seeds from one of the plants, which rose to eight feet in height. This plant is now propagating in the botanic garden, in the garden of Sir Alexander Dick, and many other gardens in Scotland. The root is found, by repeated trials, to be equally powerful in its operation as the best foreign rhubarb; and we have the greatest reason to hope, that in a short time this plant will be so universally cultivated as to prevent the future importation of it. The first botanic description we have of the true rhubarb was published by Dr Hope in the philosophical transactions for the year 1765\*; which we shall translate into English.

\* Vid. Phil. Trans. for the year 1765.

*d* *e* *f* *o*



RHEUM PALMATUM  
OR  
TRUE RHUBARB.





The *ROOT* *a*, is of the branchy kind, and perennial. The *LEAVES* of (which *b* in the plate is an outline) are about sixteen in number, grow near the root, about two feet long, and are furnished with petioli or foot-stalks. —The petioli are about a foot long, cylindrical, plane above, smooth, of a green colour, but in some places interspersed with small, narrow, purple spots; at the base of the leaf, the petiolus terminates in three or five large nerves or ribs, which are prominent above; the leaves are ovated, deep cut, with sharp lacinia or segments; the superior part of the base is green, the inferior of a whitish green, and both are a little rough. The *CAULIS* or *STEM* is erect, somewhat cylindrical, fistulous or hollow within, jointed, sheathed, rough, striated, about eight feet high, and about two inches over near the base. It has fourteen joints, each of which, from the base to the ninth joint, is furnished with a reflected leaf, placed alternately, gradually diminishing as they rise higher, and the petiolus forms a kind of sheath, which embraces the stem. The *PEDUNCULI* or *FOOT-STALKS* of the flowers, which are numerous, arise from the axæ or arm-pits of the leaves, are almost erect, unequal, striated, cylindrical, plainish at the base, and out of their sides other

foot-stalks arise, to be distributed in the same manner. *c*, is a flowering branch separated from the stem. The *TASTE*, *ODOUR*, and *COLOUR* of the *ROOT* are precisely the same with those of the foreign rhubarb. The *TASTE* of the *FLOWERS* is astringent, herbaceous and subacid; they have no sensible smell. The *TASTE* of the *LEAVES* is bitterish, astringent, and herbaceous; the taste of the *RIBS* or *NERVES* is acid, bitterish, and very ungrateful;—the taste of the *STEM* is a little sour.

WE have now pretty fully explained the method of reducing plants to classes, orders, genera, and species, according to the sexual system of Linnæus. The manner in which this explanation has been executed was suggested by the difficulties which naturally occur to a person unacquainted both with the subject and the system. Although this manner has not, so far as we know, been hitherto attempted, we hope it will not be the less acceptable to the public, especially as it is likely to be more useful to the botanical student.

It only now remains to make the reader more fully acquainted with the origin and nature of the sexual system.

### S E C T: III. O F T H E S E X E S O F P L A N T S.

AS many philosophers and botanists deny that such a thing as the distinction of sexes takes place in vegetables, it will be necessary to give a narration of the arguments employed by both parties on this subject. We shall begin with the arguments in favour of the sexes.

LINNÆUS, like every person attached to a particular doctrine or theory, is at great pains in tracing the notion of sexes in plants to the remotest periods of antiquity. He informs us, that Empedocles, Anaxagoras, and other ancient philosophers, not only attributed the distinction of sexes to plants, but maintained that they were capable of perceiving pleasure and pain.

Hippocrates and Theophrastus are next introduced as distinguishing the conyza, the abies, the filix, &c. into male and female. The latter of these writers affirms, that the fruit of the female palm will not germinate unless the pollen of the male be shaken over the spatha of the female, previous to the ripening of the seed.

Dioscorides takes notice of a male and female mandragora, mercurialis, cistus, &c.

Pliny does not confine his views of sex to animals, but exclaims, that every thing this earth produces is characterized by the distinction of sex.

From the days of Pliny to those of Cæsalpinus, who lived in the 16th century, the analogy between the vegetable and animal seems to have been entirely neglected. Cæsalpinus tells us, that the males of the oxycedrus, taxus, mercurialis, urtica, and cannabis, are barren; and that the females of these plants only bear fruit.

After Cæsalpinus, we find Dr Grew and Sir Thomas Millington engaged in a conversation concerning the uti-

lity of the stamina and styli of plants. The result of this conversation was the mutual agreement of these two eminent naturalists, that the stamina and styli of vegetables were analogous to the organs of generation in animals, and that they were adapted by nature to answer the same purposes. Dr Grew, in his anatomy of plants, after enumerating the analogies between plants and animals, concludes, that the pollen probably emits certain *vivific effluvia*, which may serve for the impregnation of the seeds.

Mr Ray gave a further sanction to the doctrine of sexes, by concurring with Grew, and adding some further illustrations from analogy.

In the year 1695, Camerarius attempted to prove the sexes of plants. But, as he trusted solely to the palm-tree, and withal seemed to be doubtful as to the authenticity of the fact, he cannot be considered as having done any thing in confirmation of the sexual hypothesis.

Mr Morland, in the year 1703, adopted the same hypothesis; but gave it a new modification, by supposing that the pollen contained the seminal plant in miniature; and consequently, that one pollen at least behaved to be conveyed into every separate seed before it could be properly impregnated. Analogy and the structure of the parts are the only arguments he employs.

Some years after this, Mr Geoffroy wrote a treatise on the sexes of plants: But as he advanced nothing new, we shall take no further notice of him.

Vaillant, in the 1717, judiciously considering that the canal in the stylus of most plants was too narrow to admit the pollen itself, republished Dr Grew's theory of impregnation by means of a subtle seminal aura.

These

These are the sentiments of the principal botanists with regard to the generation of plants, till the celebrated Linnæus made his appearance as a botanical writer, who has extended the idea so far as to compose a complete system upon it.

Although Linnæus can have no claim to the supposed discovery of the sexual hypothesis, his being precisely the same with that of Dr Grew; yet, as he is the chief supporter and improver of this doctrine, we shall give a succinct narration of the arguments he makes use of in order to prove that vegetables propagate their species by a regular commerce of sexes.

In a treatise, intitled, *Sponsalia Plantarum*, published as an inaugural dissertation by Wahlbom, in the first volume of the *Amenitates Academica*, all the arguments made use of by Linnæus in his *Fundamenta Botanica* and other works, are collected and arranged in one view. But as Wahlbom honestly attributes all the merit of this dissertation to his great master, we shall here drop his name altogether, and give the arguments as the property of Linnæus, by whom they were originally employed.

Linnæus, then, first attempts to show, that vegetables are endowed with a certain degree of animal life; and, secondly, that they propagate their species in a manner similar to that of animals.

"That vegetables are really animated beings," says he, "must be obvious at first sight; because they possess all the properties contained in that accurate definition of life laid down by the great Dr Harvey, namely, *Vita est spontanea propulsio humorum*. But universal experience teaches, that vegetables propel humours or juices: Hence it is plain that vegetables must be endowed with a certain degree of animal life."

Not trusting solely to a syllogism founded on a definition, Linnæus proceeds to support the life of vegetables by arguments drawn from the following particulars in their œconomy; the first of which he intitles

"*Nutritio*.—The very idea of nutrition implies a propulsion of humours, and, of course, the idea of life. But vegetables derive their nourishment from the earth, air, &c. and consequently must be considered as living creatures.

"*2. Ætas*.—Every animal must not only begin to exist, and have that existence dissolved by death, but must likewise pass through a number of intermediate changes in its appearance and affections. *Infancy, youth, manhood, old age*, are characterised by *imbecillity, beauty, fertility, dotage*; are not all these vicissitudes conspicuous in the vegetable world? Weak and tender in *infancy*; beautiful and salacious in *youth*; grave, robust, and fruitful in *manhood*; and when *old age* approaches, the head droops, the springs of life dry up, and, in fine, the poor tottering vegetable returns to that *dust* from whence it sprung.

"*3. Motus*.—No inanimate body is capable of self-motion. Whatever moves spontaneously is endowed with a living principle; for motion depends on the spontaneous propulsion of humours, and where-ever there is a spontaneous propulsion of humours, there also is life. That vegetables are capable of motion is evident from the following facts: Plants, when confined within doors, at-

ways bend towards the light, and some of them even attempt to make their escape by the windows. The flowers of many plants, especially those of the syngenesia class, pursue the sun from east to west, rejoicing in his beams. Who then can deny that vegetables are possessed of living and self-moving powers?

"*4. Morbus*.—The term *disease* means nothing more than a certain corruption of life: It is well known, that vegetables are subject to diseases as well as animals: When over-heated, they turn thirsty, languish, and fall to the ground: When too cold, they are tormented with the chilblain, and not unfrequently *expire*: They are sometimes afflicted with cancers; and every plant is infested with lice peculiar to its species.

"*5. Mors*.—Death is opposed to life, the former being only a privation of the latter: Experience shows, that every living creature must die: But, as vegetables are daily cut off by internal diseases and external injuries; as they are subject to death from the attacks of hunger, thirst, heat, cold, &c. with what propriety could vegetables be thus said to *die*, unless we allow that they previously *lived*?

"*6. Anatomia*.—Under this article we are referred to Malpighius and Grew for the organic fibres, membranes, canals, vesicles, &c. of plants, as additional proofs of their living powers.

"*7. Organizatio*.—Vegetables not only propel humours, but also prepare and secrete a number of different juices for the fruit, the nectar, &c. analagous to the various secretions in animal bodies."

From these facts and observations, Linnæus concludes, that plants are unquestionably endowed with life as well as animals; and then proceeds in the following manner to shew how these animated vegetables propagate their species.

After discussing the long exploded doctrine of equivocal generation, he lays hold of another maxim of Dr Harvey, *viz. Omne vivum ex ovo*.—"It being fully evident," says he, "from the foregoing chain of reasoning, that vegetables are endowed with life, it necessarily follows, agreeable to this maxim of Harvey's, that every vegetable must in like manner derive its existence from an *egg*. But as vegetables proceed from eggs, and as it is the distinguishing property of an egg to give birth to a being similar to that which produced it, the seeds must of course be the *eggs* of vegetables.

"Granting then that the seeds of vegetables are intended by nature to answer the same end as the eggs of animals, and considering at the same time that no egg can be fecundated without receiving an impregnation from the male, it follows, that the seed or eggs of vegetables cannot be fecundated by any other means. Hence also the necessity of vegetables being provided with organs of generation. But where are these organs situated? The answer is easy:—We have already found impregnated seeds within the flowers of plants; and it is natural to expect that the *genitalia* should not be at a great distance. Now, as *copulation* always precedes *birth*, and every *flower* precedes the *fruit*, the *generating faculty* must be ascribed to the *flower*, and the *birth* to the *fruit*. Again, as the *antheræ* and *stigmata* are the only essen-

tial

tial parts of flowers, these parts must necessarily be the organs of generation."

Being thus far advanced, Linnæus affirms, that the antheræ are the testes, and that the pollen performs the office of the male semen. These affirmations he attempts to establish by the following arguments; the first of which he terms

" 1. *Præcedentia*.—The antheræ, or vegetable testes, always precede the fruit; and as soon as the antheræ come to maturity, which constantly happens before the maturity of the fruit, they continue to throw out their pollen as long as the flower lasts; but decay and fall off whenever the fruit comes to perfection.

" 2. *Situs*.—The antheræ of all plants are uniformly situate in such a manner that the pollen may with the greatest facility fall upon the stigma or female organ.

" 3. *Tempus*.—The antheræ and stigmata always flourish at the same time, whether the flowers be of the hermaphrodite or dioicous kind.

" 4. *Localumenta*.—When the antheræ are dissected, they discover as great a variety of structure as the pericarpia or seed-capsules: For some of them have one cell, as the mercury; some two, as the hellebore, &c.

" 5. *Castratio*.—If all the antheræ be cut off from an hermaphrodite plant, just before the flowers begin to expand, taking care at the same time that no plant of the same species grows near it, the fruit will either prove entirely abortive, or produce barren seeds.

" 6. *Figura*.—When the pollen of different plants is examined by the microscope, it exhibits as great a variety of figures as is discoverable in the seeds themselves.

" The accumulated force of these arguments", concludes Linnæus, "amounts to a full demonstration that the antheræ are the testes, and that the pollen is the semen or genitura of vegetables.

" The male organ being thus investigated, we hope," says Linnæus, "that none will hesitate to pronounce the stigma to be the female organ, especially when the following observations are sufficiently attended to.

" The pistillum is composed of the germen, stylus, and stigma. The germen being only a kind of rudiment of the future fœtus or seed, ceases to exist as soon as the flower comes to maturity. Neither is the stylus an essential part, as many flowers have no stylus. But no fruit ever comes to maturity without the assistance of the stigma. It follows, that the stigma must be the female organ adapted by nature for the reception of the pollen or impregnating substance. This will appear still clearer from the following chain of reasoning.

" 1. *Situs*.—The stigmata are always situate so that the pollen may with most ease fall upon them. Besides, it is remarkable, that in most plants (though not in all) the number of the stigmata exactly corresponds with the localumenta or cells of the pericarpium.

" 2. *Tempus*.—Here the observation, that the stigmata and antheræ constantly flourish at the same time, is repeated.

" 3. *Decidentia*.—The stigmata of most plants, like the antheræ, decay and fall off as soon as they have discharged their proper function; which evidently shows,

that their office is not to ripen the fruit, but solely to answer the important purpose of impregnation.

" 4. *Abscissio*.—The argument here is precisely the same with the castration of the antheræ; and the result is likewise the same, namely, the destruction of the fruit.

" These arguments," concludes Linnæus, "are sufficient to demonstrate, that the stigma is the female organ of generation, or that organ which is suited for the reception and conveyance of the semen to the vegetable eggs. Hence, plants may be said to be *in actu veneris*, when the antheræ, or testiculi, spread their pollen over the stigma or female vulva."

To show how the *ovitus* of vegetables is effected, is our author's next object of investigation. He affirms, that the pollen is conveyed, by means of the wind or insects, to the moist stigma, where it remains until it discharges a subtile fluid, which, being absorbed by the vessels of the stigma, is carried to the seeds or ova, and impregnates them. His proofs are taken from the following particulars.

" 1. *Oculus*.—When the flowers are in full blow, and the pollen flying about, every one may then see the pollen adhering to the stigma. This he illustrates by mentioning as examples the *viola tricolor*, *iris*, *campanula*, &c.

" 2. *Proportio*.—The stamina and pistilla, in most plants, are of equal heights, that the pollen, by the intervention of the wind, may, with the greater facility, fall upon the stigma.

" 3. *Locus*.—The stamina of most plants surround the pistillum, to give the pollen an opportunity of falling on the stigma at every breeze of wind. Even in the monœcia class, the male flowers stand generally above the female ones, to afford an easier conveyance of the pollen to the stigma.

" 4. *Tempus*. It is remarkable that the stamina and pistilla constantly appear at the same time, even in plants belonging to the monœcia class.

" 5. *Pluvia*.—The flowers of most plants expand by the heat of the sun, and shut themselves up in the evening or in rainy weather. The final cause of this must be, to keep the moisture from the pollen, lest it should be thereby coagulated, and of course prevented from being blown upon the stigma.

" 6. *Palmicolæ*.—That the cultivators of palm trees were in use to pull off the spadices from the males, and suspend them over the spathæ of the females, is attested by Theophrastus, Pliny, Prosper Alpinus, Kempfer, and many others. If this operation happened to be neglected, the dates were four and destitute of nuts. Kempfer adds this singular circumstance, that the male spadix, after being thoroughly dried and kept till next season, still retained its impregnating virtue.

" 7. *Flores nutantes*.—As the pollen is specifically heavier than air, such flowers as have their pistillum longer than the stamina, hang down, or incline to one side, *e. g.* the *fritillaria*, *campanula*, &c. An easy admission of the pollen to the stigma, is the final cause of this appearance.

" 8. *Submersi*.—Many plants that grow below water, emerge when their flowers begin to blow, and swim upon

upon the surface till they receive their impregnation, and then sink down.

“9. *Omnium florum genuina consideratio*.—Here a number of particulars are recited. We shall confine ourselves to those that are most striking and applicable to the subject.

“When the flowers of the male hemp are pulled off before those of the female are fully expanded, the females do not produce fertile seeds. But as a male flower is sometimes found upon a female plant, this may be the reason why fertile seeds are sometimes produced even after this precaution has been observed.

“The tulip affords another experiment to the same purpose.—Cut off all the antheræ of a red tulip before the pollen is emitted; then take the ripe antheræ of a white tulip, and throw the pollen of the white one upon the stigma of the red; the seeds of the red tulip being thus impregnated by one of a different complexion, will next season produce some red, some white, but most variegated flowers.”

In the year 1744, Linnæus published a description of a new genus, which he called *peloria*, on the supposition of its being a *hybrid* or *mule* plant, *i. e.* a plant produced by an unnatural commixture of two different genera. The root, leaves, caulis, &c. of this plant are exceedingly similar to those of the *frutirrhinum linaria*; but the flower and other parts of fructification are totally different. On account of its similarity to the *linaria* in every part but the flower, Linnæus imagined it to have been produced by a fortuitous commixture of the *linaria* with some other plant, although he has never yet been able to condescend on the father. This doctrine of the production of *mule* plants has since been greatly prized and carefully propagated by Linnæus and the other supporters of the sexual hypothesis. In the third volume of the *Amentitates Academica*, there is a complete dissertation, intitled, *Plantæ Hybrida*, wherein the doctrine of *vegetable mules* is much improved and extended. This dissertation contains a list of 47 mules, with their supposed fathers and mothers. For example,

The *VERONICA SPURIA* is said to be a *mule* plant *begot* by the *verbena officinalis* upon the *veronica maritima*.

The *delphinium hybridum*, a *mule* *begot* by the *aconitum napellus* upon the *delphinium elatum*.

The *arctotis calendula*, a *mule* *begot* by the *calendula pluvialis* upon the *arctotis tristis*.

The *asclepias nigra*, a *mule* *begot* by the *cynanchum acutum* upon the *asclepias vincetoxicum*, &c.

From the examples given in this dissertation, Linnæus draws this singular conclusion, that only two species of each genus existed *ab origine*; and that all the variety of species which now appear have been produced by unnatural embraces betwixt species of different genera.

Under this head, Linnæus likewise quotes from Ray the story of Richard Baal gardener at Brentford. This Baal sold a large quantity of the seeds of the *brassica florida* to several gardeners in the suburbs of London. These gardeners, after sowing their seeds in the usual manner, were surpris'd to find them turn out to be plants of a different

species from that which Baal made them believe they had purchased; for, instead of the *brassica florida*, the plants turned out to be the *brassica longifolia*. The gardeners, upon making the discovery, commenced a prosecution of fraud against Baal in Westminster-hall. The court found Baal guilty of fraud, and decreed him not only to restore the price of the seeds, but likewise to pay the gardeners for their lost time, and the use of their ground. “Had these judges (says Linnæus) been acquainted with the sexual hypothesis, they would not have found Baal guilty of any crime, but would have ascribed the accident to the fortuitous impregnation of the *brassica florida* by the pollen of the *brassica longifolia*.”

Linnæus next proceeds to celebrate the utility of insects, because they convey the pollen of the male to the stigma of the female. “In this way,” says he, “it is reasonable to think that many dioicous plants are impregnated. Nay, even the hermaphrodites themselves are greatly obliged to the different tribes of insects, which, by fluttering and treading in the corolla, are constantly scattering the pollen about the stigma.

“Upon the whole,” then, concludes Linnæus, “the coitus of vegetables is evident to a demonstration. This coitus is nothing more than the conveyance of the pollen to the stigma, to which it adheres till it bursts and discharges a subtile elastic fluid. This fluid or aura is absorbed by the vessels of the stylus, and carried directly to the ovarium or germs, where the mysterious work of impregnation is fully completed.”

THESE are the arguments employed by Linnæus and other advocates for the sexual commerce of vegetables.—Let us next attend to those employed by the opposers of this hypothesis.

It is admitted by Pontedera, Dr Alston, &c. that some of the ancients applied the terms *male* and *female* to several plants. But then they deny that these terms conveyed the same ideas to the ancients that they do to the moderns. *Male* and *female*, when applied to plants, were to the ancients mere terms of distinction, serving only as trivial names to distinguish one species or variety from another. The ancients were ignorant of the very characters which constitute the difference between what is called a male and female plant among the moderns. Theophrastus, Dioscorides, Pliny, and, in a word, the whole ancient botanical writers, confound the very notion of the modern sexes; they call the real female, or seed-bearing plant, the *male*; and the male, or barren plant, the *female*. Nay, they have even applied the terms *male* and *female* to many plants which bear nothing but hermaphrodite flowers.

Such is the nature of this controversy, that it cannot be determined with any degree of certainty, but by experiments made upon dioicous plants. If a female plant can produce fertile seeds without having any communication with the pollen of the male, the use of this pollen, with respect to the impregnation of seeds, must of necessity be entirely superseded.

Now, both Camerarius and Dr Alston tried these experiments with the same success: Those two eminent botanists took female plants of the mercury, spinach, and hemp.

hemp, transplanted them at a great distance from any males of the same genus, and besides had them inclosed by double rows of hedges. The result was, that each of these plants produced great quantities of fertile seeds. Tournefort made the same trial upon the lupulus, Miller upon the bryony, and Geoffroy upon the mays; and all of them declare that the seeds of these plants were as fertile as if they had been surrounded by a thousand males.

Linnæus, in his first argument for the coitus of plants, refers every man to the evidences of his senses.

“Do we not see, (says he) the stigma of almost every hermaphrodite flower covered over with the pollen or impregnating substance? Do not we see the parietaria, the urtica, &c. by violent explosions, discharging their pollen in the open air, that it may be carried in that vehicle to the stigmata of their respective females?”—All this is admitted by the opposers of the sexes; but then they deny that these explosions, &c. are intended to create any intercourse between the male and the female; and further alledge, that this ejection of the pollen is intended by nature to throw off something excrementitious, or at least something, which, if retained, would prove noxious to the fructification.

Linnæus takes his second argument from the proportion which the stamina bear to the stylus, alledging that they are generally of the same height.—This observation is not only contrary to experience, but, allowing it to be universal, no conclusion can be drawn from it either for or against the sexual hypothesis.

The third argument is taken from the *locus* or situation of the stamina with respect to the stylus; “and as the male flowers in the monoecia class stand always above the female flowers, it must be concluded (says Linnæus) that the intention of nature, in this disposition of the parts, is to allow a free and easy access of the pollen to the stigma.”—But the stamina cannot be said to surround the pistillum in the monandria and diandria classes: And the position of the male flowers in the monoecia class is a mere chimera; for in the ricinus, one of the examples which Linnæus mentions in confirmation of his doctrine, the female flowers stand uniformly some inches above the males.

That the stamina and pistilla generally come to perfection at the same time, and that this happens even in the dioecious plants, is Linnæus’s fourth argument. But, as it is acknowledged by Linnæus himself, that there are many exceptions with respect to this fact, the opposers of the sexual hypothesis alledge that it carries the best answer in its own bosom.

The fifth argument is founded on the circumstance of some flowers shutting up their petals in rainy or moist evenings.—But many flowers do not shut themselves up, either in the night or moist weather, as the passion-flower, &c. The *lychnis noctiflora*, *mirabilis peruvianæ*, &c. open their flowers in the night, and shut them at the approach of the sun. Hence this is another final cause evidently perverted to support a favourite hypothesis.

We come now to the culture of the palm-tree, which is the sixth and most plausible argument employed by the sexualists. Herodotus, Theophrastus, Pliny, and some others, have informed us, that the female palm-tree, unless

a male grows sufficiently near it, or unless the pollen be artificially conveyed to the female spatha, will produce nothing but four dates and unfertile seeds. This fact is partly denied by Pere-Labat and Tournefort. The former of these authors expressly affirms, that a female palm-tree, in the garden belonging to the monastery at Martinico, produced most excellent fruit, although there was not a male within six miles of it: From which he concludes, that the presence of the male is not necessary to render this tree fruitful, whatever may be pretended by ancient or modern naturalists. Herodotus relates, that the people of Babylon, when the male was at too great a distance from the female, made a rope pass from the boughs of the one to the boughs of the other, to afford an opportunity to the culices and other insects to pass along the rope, and convey some kind of impregnating influence from the male to the female. Tournefort, when he was in that country, inquired at the most intelligent people of the place, as to the truth of this relation; but received for answer, That they had never heard of any such matter. Even the favourers of the sexual hypothesis give very different accounts of the method of cultivating palm-trees in those countries. Vespellingius, who resided many years in Egypt, denies that any artificial method is employed for fructifying the palm-trees in that country. Thus Vespellingius expressly contradicts Herodotus and many others. In a word, almost every different author gives a different account of this story. Amidst so many contradictions concerning the culture of palm-trees, the opposers of the sexes conclude, that the whole story is a vulgar error, taken for granted by some learned men, spuriously fathered upon others, and swallowed down without examination by their credulous readers.—As we have not seen any answer to Mylesius’s letter on this subject, our observations upon it shall be reserved till this historical view of the controversy be finished.

The seventh argument of Linnæus is taken from the *flores nutantes*.—The pistils of these flowers, according to Linnæus, are always longer than the stamina, and nature has assigned them this penile posture, that the pollen, which is specifically heavier than air, may the more conveniently fall upon the stigma.—But the pistils of the *campanula*, *lilium*, and many other *flores nutantes*, are not longer than the stamina. Besides, granting this were uniformly the case; yet, as the pollen is heavier than air, this posture must of necessity either make the pollen miss the pistillum altogether, or, at any rate, it can only fall upon the back part of the pistil in place of the stigma; and, of course, such a direction would rather tend to frustrate than promote the impregnation of the seed.

The eighth argument is taken from the *planta submersæ*, which are said to emerge as soon as their flowers begin to blow, lest the pollen should be coagulated or washed off by the water.—But many submarine and aquatic plants fructify entirely below water; and, supposing they did not, the same argument would equally prove it to be the intention of nature, that the pollen should be blown away by the winds, as that it should be subservient to the impregnation of the seed.

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The ninth and last argument is intitled *Omnium florum genuina consideratio*; which is nothing more than a collection of vague observations upon the structure and œconomy of particular plants, some of them true, others false, but all of them evidently thrust in as supports to a favourite hypothesis.

HAVING thus given a pretty full historical view of the controversy concerning the sexes of plants, we shall now lay before our readers a few observations that have occurred from the perusal of it.

It may be observed in general, that the facts and arguments adduced by the sexualists are by far too few to admit of any general induction. Nay, most of them are merely accidental, many of them not being uniform even in the same species; and the final causes of the whole are unnatural, and tortured so as best to answer the purposes of a theory, which, for all that hath yet been said, merits no higher appellation than that of a whimsical conjecture.

First, then, Linnæus's reasoning is of a mixt nature, partly analogical, partly founded on observation. He sets out with an attempt to prove, that plants are endowed with a certain degree of animal life; and his fundamental reason is, because, agreeable to Dr Harvey's definition of life, they *spontaneously propel humours*.—Strange, that a man of Linnæus's capacity, or indeed of any capacity at all, should seriously employ an argument pregnant with every degree of absurdity!—Stranger still that he should take up near twenty pages in illustrating and drawing conclusions from such an argument!—If Harvey has given a vague and unintelligible definition of life, can that be a sufficient excuse for laying hold of such a definition in order to fortify an unstable hypothesis? But, were Harvey's definition more accurate than it is, and were vegetables actually possessed of living powers, it is easy to conceive how the life of vegetables might be a proper test of, or contradiction to, the received definition: But, how a definition, which, from the complex and intricate nature of the subject defined, must necessarily be vague and precarious, can be employed in confirmation of any general theory, exceeds the powers of common apprehension.

But let us examine this notable definition a little further: What idea of life does a *spontaneous propulsion of humours* convey? If Harvey means to say, that men and other animals regulate the motion of their blood, and the secretions of their different humours, by certain exertions of the sentient principle, such a meaning is contradicted by universal experience; so far is this from being the case, that the most abstract attention cannot render us conscious of these motions. Again, if he means, that every body is endowed with life, whose organs are suited to propel humours, then the term *spontaneous* is absurd, because it ascribes intellectual powers to the organs themselves, than which nothing can be more ridiculous. Besides, allowing the organs to enjoy an independent faculty of propulsion, what does this propulsion mean when applied to vegetables? Surely nothing more than a power of conveying certain liquors from the root to the superior parts of the plant. A wet

cloth, with one end in contact with the water in any vessel, and the other hanging over its side, will do the same; so will a sponge, so will a bed of loose sand, so will a sugar loaf, &c.; but it is to be hoped, that mankind have more sense than to believe that a bit of cloth, or a sugar loaf, are animated beings.

As conscious of the lameness and futility of his reasoning on this subject, Linnæus endeavours further to corroborate the life of vegetables by analogies drawn from their nutrition, age, motions, diseases, death, anatomy, and organization. In these nothing new or remarkable occurs, excepting the uncommon method of reasoning, and the still more whimsical purposes to which this reasoning is applied. We shall take notice of his arguments under the articles of *motion* and *death*, which indeed are the chief of those which do not depend more or less upon the above definition.

Under the former of these, Linnæus informs us, that plants, when confined within doors, always bend towards the light; and that many flowers, particularly those of the syngenesia class, pursue the course of the sun from east to west. This inclination of flowers towards the light, Linnæus would have us to believe are real instances of the living powers and spontaneous motion of plants.—This phenomenon, however, may be easily accounted for, independent of any idea of life. Every body knows, that a certain degree of heat relaxes the tone of the vegetable organs, and at the same time proportionally evaporates the fluids which these organs contain. Now, to whatever side of the plant that heat is principally applied, there of necessity must also be the greatest flaccidity of the fibres, and the greatest evaporation of the fluids; of course, from the law of gravitation, the flower, indeed the whole plant, must incline towards that side from whence the light or heat proceeds. The slightest observation is sufficient to convince us of the propriety of this method of accounting for the inclination of heavy flowers supported by weak stems, towards the rays of the sun. If a pot of flowers be put loosely into a glass, and allowed to remain a little time in an apartment where a fire is burning, as soon as the fibres begin to be enervated, they all, unless obstructed by some other cause, bend towards the fire. Hence the absurdity of ascribing this phenomenon to a sentient and living principle, which is more easily and with more certainty explained by the common laws of mechanism.

Let us next attend to Linnæus's argument under the article of *death*. After telling us, with much solemnity, that death is only a privation of life, and that vegetables *die* of many grievous distempers, he thus concludes; "With what propriety," says he, "could vegetables be thus said to *die*, unless it be allowed that they previously *lived*?" However, if the life of vegetables hath no other support than this trifling quibble, (for it merits not the name of argument), we are afraid that every man of common sense will conclude, that they never were endowed with *life*, and consequently cannot, with any more propriety than an ordinary figure of speech can bestow, be said to *die*.

Having in this manner attributed living powers to vegetables, Linnæus, in the next place, makes an effort to show

show, that they enjoy the faculty of generation. But what process of argumentation does he employ? He lays hold of another maxim of Dr Harvey: *Omne vivum ex ovo*, says Harvey. "Now," adds Linnæus, "we have already proved that vegetables *live*; and therefore they must in like manner derive their origin from eggs. Again, no eggs can be fertilized without receiving an impregnation from the semen of the male: And hence the eggs or seeds of vegetables must likewise be impregnated by the male vegetable semen, in order to their fertilization. Further, it is an essential property of an egg to produce a creature of the same species with that from which itself was produced: Hence the seeds are the eggs of vegetables. Besides, as the antheræ and stigmata are the only essential parts of a flower, it follows, that these parts are the organs of generation." In this way Linnæus goes on till he finds the antheræ to be the testes; the pollen, the semen; and the stigma, the female organ of generation.

But, as we have already shewn that Linnæus has remarkably failed in the proof of his first point, namely, that vegetables are endowed with life, his subsequent reasoning, which rests solely on the supposition of the living powers of vegetables, must of course fall to the ground.

However, allowing a *spontaneous propulsion of humours* to be a perfect definition of life, philologists are far from being agreed with regard to the propriety of Harvey's second maxim. *Omne vivum ex ovo* may be applied to a great variety of animals. But to this day it remains a very doubtful point, whether man and most quadrupeds derive their existence from the same source. Hence the impropriety of drawing an analogy from a property not universal even among the animal creation in order to support an imaginary one among the vegetable tribes.

When our author comes to explain the manner in which the *coitus* of vegetables is performed, he tells us, that the pollen may be seen lying upon the top of the stigma in most hermaphrodite flowers, where it is dissolved by the moisture which constantly adheres to that part; and after this dissolution, that the *seminal aura* contained in the pollen is absorbed by the stigma, and so conveyed directly to the seeds.

This account of the *coitus* lies open to two objections. 1st, Admitting that the pollen may be seen adhering to the stigmata of most hermaphrodite plants, and admitting likewise that moisture causes the pollen to burst and discharge a *subtile fluid*, still a very natural question occurs with regard to the absorbing quality of the stigma. It is true, that the top of the stigma is generally covered with moisture. But does not this indicate that the proper office of the stigma is to discern and propel rather than to absorb moisture? It will be the more readily admitted, that the vessels of the stigma are not suited to absorb, if it be considered that the moisture of the stigma is subjected to a constant evaporation, and of course must always stand in need of new supplies of this liquor, which can flow from no other source than the internal vessels of the stigma itself. It may indeed be alledged, that the stigma is furnished with two sets of vessels, one for absorbing the seminal fluid, another for discerning the dissolving

moisture. No body, however, has ever pretended to show that the stigma is possessed of any peculiar vessels for absorbing; whereas every man's eyes will convince him that it is possessed of discerning vessels: Hence, until the absorbing quality of the stigma be sufficiently proved, the possibility of an impregnation in this way must at least remain problematical.

2dly, Linnæus makes the appearance of the pollen adhering to the stigmata of hermaphrodite flowers an ocular demonstration of an actual *coitus*. Granting this to be an ocular demonstration of the *coitus* of vegetables, should not the pollen be likewise seen adhering to the stigmata of dioicous plants? But the appearance of pollen upon the stigmata of dioicous plants has never yet been discovered. We may, therefore, fairly conclude, that if the appearance of pollen upon the stigmata of hermaphrodite flowers be an ocular demonstration of the *coitus* or copulation of plants the want of that appearance, or no pollen's being ever seen upon the stigmata of dioicous flowers, must likewise be an ocular demonstration of the contrary!

In supporting theoretical opinions, mankind are extremely apt to render the subject ridiculous by pushing them too far. No man ever blundered more remarkably in this respect than Linnæus. He is not satisfied with attributing life and a generative faculty to plants: He must likewise attempt to prove, that this generative faculty is so strong and vigorous, as to enable them to produce hybrids or *mules*, by means of unnatural mixtures.

In support of this notion, he tells us, that, when the antheræ of a red tulip are cut off, and the ripe antheræ of a white one are shaken over the stigma of the red one, the seeds of the red tulip, by this artificial impregnation, will produce flowers streaked with red and white. Of this fact no body who knows any thing of the nature of tulips, and the changes to which the colour of their flowers are liable, will entertain any doubt. But this change of colour is evidently ascribed to a wrong cause; for the same change would unquestionably happen whether the antheræ of the white tulip had been shaken over the stigma of the red one or not. When tulips blow for the first time, their petals are generally of one uniform colour. For several succeeding seasons this original colour continues to vary, in so much that, by certain methods of culture, the colour of the flower may be varied without end. Linnæus, in his systematic works, wisely cautions his readers not to found any distinctions upon the colour of plants, which, he observes, is subject to such numberless alterations from culture, soil, and other casual incidents, that it can never furnish the botanist with any permanent or uniform marks. With what propriety, then, Linnæus attributes the change in the colour of this tulip to his artificial impregnation, is submitted to the consideration of his warmest admirers.

The first hint of *mules* was taken from a plant the figure and disposition of whose leaves, &c. resembled the *antirrhinum linaria*, or common yellow toad-flax; but attended with this peculiarity, that its parts of fructification were entirely dissimilar. Linnæus, when the plant was first presented to him, imagined it to be some kind

of deception. But, after a more accurate examination, the notion of a *spurious* issue opportunely came to his aid. The thought pleased him on a double account: It had a direct tendency to corroborate his favourite hypothesis, and laid the foundation of another still more extravagant. Now, thinks he, by this inestimable discovery, we shall be enabled to take a dry and rigid plant from the mountain's top, make it copulate with a moist and spongy aquatic, and their offspring will participate of the rigidity and hardness of the former, together with the moisture and flaccidity of the latter; and hence mankind shall soon be blessed with an easy purchase of their united virtues when flourishing in the intermediate vale! More wonderful still, we shall cause the plants which dwell upon the frozen mountains of Greenland to *intermarry* with the more delicate and wayward inhabitants of the torrid zone, and the constitutions of their children shall be so moulded and attempered, that they will live most comfortably in every temperate clime!—Not contented with extracting two theories out of this single plant, Linnæus forms a third still more wild and fantastical: "From this curious phenomenon," says he, "it is natural to think, that only two species of each genus existed *ab origine*, and that all the variety of species which now appear are only the span of fortuitous commixtures!"

If either the fortuitous or artificial copulation of two different species were capable of producing a third perfectly distinct from the other two, the number of species would be infinite. According to our author, every blast of wind, every butterfly, would daily produce hundreds of new species. Neither the gardener nor husbandman could purchase seeds with safety, unless they could discover, from inspection, whether they had been impregnated by the semen of the same, or of a different species. Linnæus would have us to believe, not only that different species of the same genus copulate together, but even that genera belonging to different classes engender, and beget mules. For example, he makes the poterium hybridum a mule, *begot* by the agrimonia eupatoria upon the poterium sanguiforba. The agrimonia belongs to the decandria digynia class, and the poterium to the monœcia polyandria. Now, let any man seriously consider the unavoidable consequences that would follow on the supposition that this wanton prostitution of sexes really existed among vegetables. In the first place, it would be impossible to reduce botany to any regular system; for every season would produce such a troop of new and strange plants, as would confound every scheme or method of classification that ever was, or ever will be invented. A botanist, for instance, carefully collects and preserves the seeds of the poterium, in order to raise that plant next season; but, after sowing the seeds, to his utter astonishment, not a single poterium appears, but every one of them is metamorphosed into a species of agrimonia, a plant so totally different that it cannot even be arranged under the same class. 2dly, Linnæus is obliged to confess, that his *vegetable mules*, are not subjected to that perverse law of nature, which cruelly prevents animal mules from propagating their species. On the contrary, his vegetable mules enjoy all the sweets of mutual em-

braces, and all the comforts that arise from a numerous progeny! It is a happy circumstance that the œconomy of nature is not influenced by the whims and caprices of those very ingenious and learned gentlemen whose heads are constantly hunting after hypothetical phantoms. There is hardly a general theory of the œconomy of animals, or vegetables, which, on the supposition of its truth, would not in a very short time extirpate both animals and vegetables from the face of the earth. In the theory under consideration, we have not only mules produced by different genera and species, but these very mules successfully propagating their kinds, and subject to be metamorphosed *ad infinitum* by subsequent impregnations. This would be strange work indeed! How unlike the œconomy of nature!—Let us take an example, and trace it through a few metamorphoses. A nettle receives an impregnation from an oak, the seed falls to the ground, a plant of a very uncouth aspect springs up; it is no longer a nettle, neither is it an oak; but then it makes an excellent *mule*! This mule next receives an impregnation from a turnip; the seed now brings forth neither a nettle, an oak, nor a common mule, but something so monstrous that no language can afford a name for it! These are a few of the consequences that would inevitably happen, if this theory of sexual embraces were really founded in nature.

It is natural to think, that no author would venture to publish a theory of this kind, without having previously made a great variety of successful experiments. If plants were really capable of unnatural commixtures, any person might make many hundred mules in the space of twelve months. But we can affirm with confidence, that Linnæus never made a single *vegetable mule* in his life. He has indeed collected forty-seven plants which he calls mules. Why? not because they were produced by an artificial or fortuitous impregnation; but because the leaves, stem, or parts of fructification have a resemblance to some other genus or species; even of these forty-seven he acknowledges that thirteen cannot be depended upon. The only attempts he has made to produce mules, have been confined to a few hermaphrodite plants: When endeavouring to *impregnate* a plant, Linnæus proceeds in this manner: He lays hold of a hermaphrodite plant just before the flowers begin to blow; unfolds the petals, cuts off all the stamina, and then with his own hands performs the office of a male plant, by shaking the pollen of a different species over its pistillum. This operation being finished, he sows the seeds next season:—Now, if Linnæus's theory were just, these seeds should produce mules, or plants which cannot be referred to any of the two species upon which the experiment was made. But all the changes he has ever been able to produce by his manual impregnations are confined to the colour of the flower; a different streak or shade in the petals passes with him for a mule or mixture of the species, although, in other parts of his works, he positively declares, that generic or specific differences can never be taken from the colour of flowers, as it is constantly liable to a thousand changes from causes that are merely fortuitous.

But no experiment can be made with any degree of candor upon hermaphrodite flowers. No man can determine  
with



with certainty what changes the young seeds may undergo, what injury they may suffer, by prematurely forcing open their petals and cutting off the stamina. If a pregnant animal be wounded, and in a part too intimately connected with the fœtus, what reason have we to hope for a beautiful or well-proportioned offspring? One thing however is certain, that if the office of the stamina, as is alleged by the opposers of the sexes, be to separate and carry off noxious or excrementitious matter from the fruit, the retention of this matter would of itself introduce a change into the colour of the future plant; because in that case the seeds would not be properly purged or rectified, being prematurely deprived of the vessels destined for that purpose.

We shall now examine the famous story of Baal the gardener at Brentford, related above in the historical view of the controversy. Linnæus accuses Baal's judges of ignorance, because they convicted him of fraud. But, would not any judge smile to hear himself branded with ignorance, or a partial administration of justice, merely because he paid no regard to the sexual commerce of plants in his decisions? It is happy for mankind that judges are obliged to decide according to law or equity, and not according to the hypothetical whims of the naturalist.—But, even supposing Baal's judges to have had a perfect knowledge of the sexual commerce of vegetables, and to have been at full liberty to determine the point of law upon that medium, if they had acquitted Baal of fraud, or at least of negligence, we should have been inclined to doubt both of their integrity and ingenuity.—It is acknowledged, that great quantities both of the *brassica florida* and *brassica longifolia* were raised that season in Baal's garden. A seedman or gardener, in packing up many parcels of different seeds, by the simple error of putting a wrong mark upon any of the parcels, would produce a mistake similar to this of Baal's. But, whether the circumstance took its rise from negligence or fraud, belongs not to our present inquiry. Even upon Linnæus's own principles, it is far from being clear of absurdity, how, by a casual impregnation, the species of a plant could be entirely changed. For, by the analogy of all animals, nay, taking our analogy from Linnæus's vegetable mules, this fortuitous impregnation should have only produced a mule, or mixture of the two species, and not a perfect metamorphosis of either. Hence it may be fairly concluded, that this famous story, upon which the sexualists lay so much stress, instead of strengthening, tends to the final destruction of that hypothesis in support of which it was originally adduced.

Of a similar nature is the story contained in Mylius's letter to Dr Watson. This gentleman writes to his correspondent, "that a female palm tree grew many years in the garden belonging to the Royal Academy at Berlin, without producing any ripe or fertile fruit; that a male branch, with its flowers in full blow, was brought from Leipzig, which is about twenty German miles from Berlin, and suspended over the female; the result of this operation was, that the female, that very year, produced 100 ripe and fertile fruit. The same experiment being repeated the following year, 2000 ripe fruit were pro-

duced."—Not to call Mylius's veracity in question, we shall allow the fact to be as he has related it: Nevertheless it is far from being satisfactory. Berlin is not the native climate of palm-trees. Mylius informs us, that this palm bore flowers and fruit for thirty years before the experiment was tried; but the fruit never came to full maturity. Now it is well known, that many exotic plants, particularly those of the larger kinds, seldom produce ripe fruit in a climate which is not adapted by nature for their nourishment, unless they are assisted by artificial culture, and have grown in that climate for a great number of years. Mylius's palm-tree had carried unripe fruit for the space of thirty years. Now, according to the usual course of exotics, it is natural to think that, during all this time, the fruit was every season making gradual advances towards perfection: It might so fall out, then, that at the very season when the male branch was suspended over the female, the plant had arrived at the highest degree of perfection it could ever acquire in the climate of Berlin; and of course, the accidental circumstance of suspending the male branch over it, at this critical period, might give rise to the deception of attributing the perfection and fertilization of the fruit to the presence of the male branch. The circumstance of the tree's bringing forth only 100 ripe fruit the first year, and 2000 the second, remarkably favours this account of the matter.

However, be this as it will, the experiment is so very defective, that no conclusion can be drawn from it either for or against the sexual hypothesis. To convince any thinking person, that the fertility of this tree was solely owing to some impregnating virtue derived to it from the male branch, a branch should have been suspended over the female one year, omitted the next, and so on alternately for a course of years, or (as Linnæus would express it), giving her a husband one year, and depriving her of that gratification the next. After treating the female in this manner for several years, if it had uniformly happened, that the fruit was fertile every year, the male branch was suspended over it, and infertile every year that the suspension of the male branch was omitted, then indeed there would have been a foundation for concluding, that there was some connection between the fertility of the fruit and the presence of the male branch. But as this necessary step has been neglected, the experiment is incomplete, and the conclusion drawn from it uncandid and precipitate.

We cannot conclude our remarks on this theory, without hazarding a few observations on the truly miraculous effects which Linnæus ascribes to the wind. In accounting for the impregnation of all the dioicous and most of the hermaphrodite plants, recourse is constantly had to the wind, which is said to convey the pollen of the male to the stigmata of the female. When the female again is at such a distance as to render the carriage of the pollen suspicious or impossible, our author is not discouraged by this circumstance, but confidently affirms, that some insect has been rummaging amongst the stamina of the male, carries off a quantity of the pollen adhering to its legs, and, unconscious of its precious load, flies from flower to flower till it arrives at the *unmarried* female, where

where stopping to take another bait, it luckily deposits some of this adhering pollen directly upon the stigma of the female!—

Here it is proper to observe, that generation is one of the capital, and indeed one of the most important laws of nature that we are acquainted with. The laws of nature are all fixed, steady, and uniform in their operation. None of the effects produced by them are subject to those uncertainties which always result from chance or any fortuitous train of circumstances. But is there any thing in nature more unsettled, desultory, and capricious, than the direction and motions of the wind? Can we form a conception of any thing more casual and fortuitous than the wild and wayward paths of insects? The very supposition, therefore, that nature has left the generation of at least a tenth part of the whole vegetable tribes to these accidental causes, must be unphilosophical, whimsical, and absurd. We will be the more readily convinced of the absurdity of this doctrine, when it is considered that many of the monœcious and dioicous plants are of the utmost importance to the human race, and the consequent impropriety that the fructification of these should be subject to the sport of the winds.

After all, it requires the utmost stretch of fancy to conceive the possibility of a regular impregnation by means of the wind, even when the male and female are within 500 yards of each other, which is a much more favourable supposition than two, three, or according to some authors, a dozen of miles. Conceive then a male and female hemp, or any other dioicous plant, growing 500 yards asunder. Let the male and female flowers, which, by the by, is not always the case, blow at the same time. Well, the antheræ are fully ripe; the pollen is discharged; and the stigma, as our author expresses it, *gaping wide* for its reception. Now, even this favourable supposition is subject to so many accidents, and pregnant with such a troop of improbabilities, that it is absolutely impossible, upon any principles of belief hitherto invented, to be fully persuaded that the pollen, in such circumstances, can be thus conveyed on the wings of the wind, directly to the stigma, a point in most plants just not invisible.—To accomplish a regular impregnation in this way, whenever the antheræ are ripe, the wind must blow in a direct line from the male to the female; if the blast be too strong, it will overshoot the mark; if too weak, it will fall short of it; if any vegetable or other body higher than the plants themselves intervene, the progress of the pollen will be intercepted;—if it rains, the pollen will be beat to the ground;—the least tremor of the air, or smaller blast reflected from any other quarter, will infallibly alter the direction of this fluctuating pollen.—Nay, supposing Linnæus, or any other expert botanist, should take his station by the male plant, having his pockets loaded with pollen; suppose him further to take every advantage of wind and weather, and aiming at the female, let him, for hours together, throw at her repeated handfuls of this fructifying pollen, it is a thousand to one, if, at the distance of 500 yards, a single grain of pollen would touch any part of the female, and many millions to one against its falling directly upon the stigmata of her respective flowers. In a word, this theory

of impregnation by the wind, is a palpable refuge of ignorance, invented with a view to account for the fructification of dioicous plants, which Linnæus knew to be a formidable barrier standing in opposition to the sexual hypothesis. How far that obstacle is removed by this vague subterfuge, is submitted to the judgment of every candid inquirer.

Upon the whole, we have endeavoured to show, that every fact or experiment Linnæus has employed to support his theory of the procreation of vegetables by means of sexual embraces, is either false, or accidental; and that the conclusions drawn from them are unnatural, and often strained to such a pitch of extravagance as renders them truly ridiculous.

The only argument that now remains to be examined, is drawn from the analogy betwixt animals and vegetables. That many beautiful analogies may be traced betwixt the animal and vegetable, is an undeniable truth. But, in reasoning upon a physical subject, which admits of a clear determination by experiment, to trust solely or chiefly to analogical deductions, is an evident mark either of a bad reasoner or an unstable hypothesis. The very nature of analogy presupposeth some radical difference in the subjects between which the resemblance subsists. If the analogy be supported by facts and experiments, they mutually strengthen the evidence. But, if the analogy be not supported by facts and experiments, or, if the experiments contradict the analogy, which is the case with the theory under consideration; in either of these instances the analogy is carried beyond its proper limits, and affords no argument in favour of the hypothesis. Without the concurrence of facts, how can we be certain but that the very property we contend for constitutes the essential difference betwixt the two subjects? Without facts, how can we be certain but that generation by the intercourse of sexes is the identical characteristic by which an animal and vegetable are distinguished? These principles are applicable even in the case of a perfect and uniform analogy, but acquire an accumulated force when the analogy is partial and incomplete, which is evidently the case with regard to the sexual commerce of vegetables.

For example, to complete the analogy in dioicous plants, a male should be uniformly found growing by the side of the female; and besides, at the age of puberty, or as soon as the antheræ come to maturity, the male flower should be situated in such a manner, that the pollen could not possibly miss the stigmata of the female flowers, from whatever quarter the wind might blow: the same thing should take place with regard to the monoicous flowers. But this is not the analogy presented to us by nature. On the contrary, the males and females seldom grow in the neighbourhood of each other. Nothing is more common than to meet with large beds of males growing in one place, and large beds of females at the distance of some miles from them, pointing out, as it were, that no necessary connection, no mutual affection, no natural dependence subsisted between these males and females; but rather that nature intended, for some purpose or other, that they should be kept at a distance.

Farther, the sexualists, in support of their theory, are

are obliged to have recourse to the unpardonable impropriety of employing a double analogy, the one betwixt the animal and vegetable, the other betwixt two different tribes of vegetables. In order to account for the propagation of the musci, fungi, and, in a word, the whole cryptogamia class, whose parts of generation are either wanting altogether, or invisible to our eye-sight, Linnæus maintains, that, this circumstance notwithstanding, they propagate their species by a regular and uniform commerce of sexes. "As it has been proven (says he) that all those plants whose organs of generations are visible, propagate their species by male and female embraces; therefore all those whose organs are less subject to our observation, must likewise propagate in the same way." Before such reasoning as this can admit even of a decent apology, before the sexualists attempt to shew that such plants enjoy the faculty of generation, it is incumbent on them to prove that they are possessed of generating organs.

According to the doctrine of sexes in vegetables, another capital defect, or rather redundancy, occurs in the analogy between the animal and vegetable. It is one of the most benevolent and useful laws in nature, that *mules*, or such animals as are produced by the unnatural commixtures of two different kinds, are deprived of the capacity of propagating their *monstrous* species. It is true, Linnæus's *mules* are not obliged to comply with this law; they are not animal but *vegetable mules*; and consequently may freely transmit their *monstrous issue* to posterity! As they are not objects of rewards or punishments, they cannot be answerable for the horrid consequences of turning the whole vegetable world into confusion, and covering the face of the earth with monsters horrible to behold!

It is a trite observation, that no fault is more common among bad writers than to render their arguments ridiculous by hunting down metaphors or analogies till every shadow of resemblance be lost. It is equally true, that this blunder occurs in almost every page of Linnæus's works. But it is peculiarly unlucky when an analogy is of such a nature that it necessarily runs into obscenity when treated in this manner. In pursuing a sexual analogy, the utmost delicacy of expression is required. This however is exceedingly difficult, especially when the analogy is pushed beyond its natural limits. But, in perusing the *Sponsalia Plantarum*, one would be tempted to think, that the author had more reasons than one for relishing this analogy so highly. In many parts of this treatise, there is such a degree of indelicacy in the expression as cannot be exceeded by the most obscene romance-writer. For example, in p. 103. he says, "The calix is the *bride-chamber* in which the stamina and pistilla solemnize their nuptials;" "Vel, si mavis CUNNUS, seu LABIA ejusdem, inter quæ organa genitalia masculina & feminina, delicatissimæ istæ partes, soventur & ab externis injuriis muniuntur!—*Corolla est aulæum, vel potius nympha!*—*Filamenta* sunt *vasa spermatica*, quibus succus ex planta secretus in antheras transfertur!—*Antheræ* sunt TESTICULI.—*Pollen*, seu pulvis antherarum, *genituræ & vermiculis seminalibus* respondet.—*Stigma* est *vulva*, in qua

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"agit *genitura* maris, quæque hanc excipit.—*Stylus* est *vagina*, vel potius pars illa quæ *tubæ Fallopiæ* respondet.—*Germen* est *ovarium*; continet etiam semina subventanea seu non foecundata ante *copulam*.—*Pericarpium* est *ovarium foecundatum*."—In p. 90, &c. we meet with *virginæ vulva lascivæ hians—æstra venerea agitata, pistillum stigmatè biat, RAPACIS INSTAR DRACONIS, nil nisi masculinum pulverem affectans.*" &c. It is impossible to do justice to these expressions in any translation.

Besides the obscenity of these passages, it would be no difficult task to show that the analogies are entirely without foundation. The calix is made to represent no less than three things of very opposite natures; first, it is analogous to the *chamber of the bride*, then to the *female organ*, and last of all to the LABIA. What analogy is there betwixt the *corolla* of a plant and the *nympha* of an animal? Where is the analogy between the *pollen* and the animalcules in *semine masculino*? &c.

There is not any science which has so little connection with theory as botany. Theory may perplex and confound, but never can have the least tendency to assist the botanic student. A man would not naturally expect to meet with disgusting strokes of obscenity in a system of botany. But it is a certain fact, that obscenity is the very basis of the Linnæan system. The names of his classes, orders, &c. convey often the vilest and most unnatural ideas. For example, *diandria*, the name of his second class, is thus explained by Linnæus, "mariti duo in eodem conjugio; seu stamina duo in flore hermaphrodito;" *i. e. one female married to two males; or two stamina in a hermaphrodite flower.* The number of males goes on increasing till the 13th class, the plants belonging to which are said to have from 20 to 1000 husbands to one wife!—We might ask Linnæus, where is the analogy in this supposition? The syngenesia class is thus defined by Linnæus: "Mariti genitalibus foedus constituerunt; seu stamina antheris in cylindrum coacta;" *i. e. the males have made a covenant with their testes; or the stamina are united by the antheræ in the form of a cylinder.* The characters of the orders are still worse. *Polygamia frustranea*, the name of an order of the syngenesia class, is thus defined: "Frustranea dicitur, cum feminæ maritatæ, fertiles sunt, et speciem propagare queunt; castræ, impregnari nequeunt." Men or philosophers can smile at the nonsense and absurdity of such obscene gibberish; but it is easy to guess what effects it may have upon the young and thoughtless.

But the bad tendency upon morals is not the only evil produced by the sexual theory. It has loaded the best system of botany that has hitherto been invented, with a profusion of foolish and often unintelligible terms, which throw an obscurity upon the science, obstruct the progress of the learner, and deter many from ever entering upon the study.

Upon the whole, we must conclude, that the distinction of sexes among vegetables has no foundation in nature; or, at least, that the facts and arguments employed in support of this doctrine, when examined with any degree of philosophical accuracy, are totally insufficient to establish it.

**BOTARGO**, a kind of sausage, made with the eggs and blood of the sea-mullet, a large fish common in the Mediterranean. The best kind comes from Tunis in Barbary: It must be chosen dry and reddish. The people of Provence use a great deal of it, the common way of eating it being with olive oil and lemon juice. There is also a great consumption of botargo throughout all the Levant.

Botargo pays on importation  $2\frac{7}{10}$ d. the pound; whereof  $2\frac{3}{10}$ d. is repaid on exportation.

**BOTATRISSA**, in ichthyology, a synonyme of a species of gadus. See **GADUS**.

**BOTE**, in our old law books, signifies recompence or amends: Thus man-bote, is a compensation for a man slain.

There are likewise house-bote and plough-bote, privileges to tenants, of cutting wood for making ploughs, repairing tenements, and likewise for fuel.

**BOTELESS**, or **BOOTLESS**, is when an offender was laid to be without emendation, when no favour can acquit him; as in the case of sacrilege.

**BOTHNIA**, the name of two provinces in Sweden, distinguished by the epithets east and west, and lying on each side the Bothnic gulf, which takes its name from them.

**BOTRYTIS**, in botany, a synonyme of a species of mucor. See **MUCOR**.

**BOTTLE**, a vessel proper to contain liquors, made of leather, glass, or stone. There are bottles of boiled leather, which are made and sold by the case-makers. Those among the ancient Hebrews were generally made of goat-skin, with the hair on the inside, well pitched and sewed together; the mouth of the bottle was through the animal's paw that furnished the matter of it.

There are now in use bottles of fine glass which are commonly covered with ozier, and others of thick glass which are not covered. Formerly all those bottles made in France held exactly a pint Paris measure (or about a quart of our English wine measure); but since the tavern-keepers sell most of their wine in such bottles, notwithstanding an ordonnance to the contrary, that one would think the glassmakers had entered into an agreement with them not to make any bottles that hold the full measure, there are none but what hold less, and some considerably so. See **GLASS-MAKING**.

In commerce, bottles of earth or stone pay  $11\frac{5}{10}$ d. each dozen, on importation; whereof  $10\frac{3}{10}$ d. is repaid on exporting them. Glass bottles covered with wicker, pay 6 s.  $7\frac{2}{10}$ d. the dozen; whereof 6 s.  $2\frac{3}{10}$ d. is repaid on exporting them. Glass bottles covered with leather, pay 1 l. 9 s.  $11\frac{7}{10}$ d. the dozen; whereof 1 l. 7 s.  $10\frac{3}{10}$ d. is repaid on exporting them. Glass bottles uncovered, pay 1 s.  $5\frac{2}{10}$ d. the dozen; 1 s.  $4\frac{7}{10}$ d. being repaid on exporting them. Bottles made of flint-glass, pay 8 d. for each pound weight; and those made of green glass, only 2 d. for each pound weight. Bottles made of wood, called *sucking-bottles*, pay by the gross, or twelve do-

zen, 1 s.  $11\frac{1}{10}$ d.; whereof 1 s.  $8\frac{5}{10}$ d. is repaid on exporting them.

**BOTTOM**, in a general sense, denotes the lowest part of a thing, in contradistinction to the top, or uppermost part.

**BOTTOM**, in navigation, is used to denote as well the channel of rivers and harbours, as the body or hull of a ship: Thus, in the former sense, we say, a gravelly bottom, clayey bottom, sandy bottom, &c. and in the latter sense, a British bottom, a Dutch bottom, &c.

By statute, certain commodities imported in foreign bottoms pay a duty called petty customs, over and above what they are liable to if imported in British bottoms.

**BOTTOMRY**, in commerce, a marine contract for the borrowing of money upon the keel or bottom of a ship, that is to say, when the master of a ship binds the ship itself, that if the money be not paid by the time appointed, the creditor shall have the said ship.

**BOTTOMRY** is also where a person lends money to a merchant, who wants it in traffic, and the lender is to be paid a greater sum at the return of the ship, standing to the hazard of the voyage. On which account, though the interest be greater than what the law commonly allows, yet it is not usury, because the money being furnished at the lender's hazard, if the ship perishes, he shares in the loss.

**BOTTONY**. A cross bottony, in heraldry, terminates at each end in three bands, knots or buttons, resembling, in some measure, the three-leaved grass; on which account Segoing, in his *Treasure Heraldique*, terms it *croix tressée*. It is the badge of the order of St Maurice. See Plate LI. fig. 17.

**BOTWAR**, a town of Wirtemberg, in the circle of Swabia in Germany, situated about fifteen miles south-east of Hailbron: E. long.  $9^{\circ} 15'$ , and N. lat.  $49^{\circ}$ .

**BOTZEN**, a very beautiful town of Germany, in the Tyrolense.

**BOTZENBOURG**, a town of Germany, situated upon the Elbe, in the duchy of Mecklenburg, in  $11^{\circ} 23'$  E. long. and  $53^{\circ} 34'$  N. lat.

**BOVA**, a town of the kingdom of Naples in Italy, about twenty miles south east of Reggio: E. long.  $16^{\circ} 15'$ , and N. lat.  $38^{\circ} 20'$ .

**BOUCHAIN**, a fortified town of Hainalt, in the French Netherlands, about seven miles north of Cambray: E. long.  $3^{\circ} 15'$ , and N. lat.  $50^{\circ} 30'$ .

**BOUCHE of court**, the privilege of having meat and drink at court, scot free. This privilege is sometimes only extended to bread, beer, and wine; and was anciently in use as well in the houses of noblemen, as in the king's court.

**BOUGE**, in commerce, a sort of fine, white, and clear flamine, of which shirts are made for most of the monks, who use none made of linen.

**BOUGH** denotes much the same with branch. See **BRANCH**.

**BOULLON**, a strong town with a castle, about three leagues from Sedan, on the river Semoy: It is capital of a duchy of the same name, situated between the duchy

- duchy of Luxemburg and bishoprick of Liege: E. lon. 5°, and N. lat. 49° 49'.
- BOUVILLON**, in the menage, a lump or excrescence of flesh, that grows either upon, or just by, the frush, insomuch that the frush shoots out, just like a lump of flesh, and makes the horse halt; and this we call the flesh blowing upon the frush. Menage horses, that never wet their feet, are subject to these excrescences, which make them very lame. See **FRUSH**.
- BOVINES**, a small town in the province of Namur, in the Austrian Netherlands, about ten miles south of Namur: E. long. 4° 50', and N. lat. 50° 20'.
- BOVINO**, a small city of the Capitanate, in the kingdom of Naples, about sixty miles east of the city of Naples: E. long. 16° 15', and N. lat. 41°.
- BOVISTA**, in botany, a synonyme of the lycoperdon. See **LYCOPERDON**.
- BOULDER-wall**, a kind of wall built of round flints or pebbles, laid in a strong mortar, and used where the sea has a beach cast up, or where there are plenty of flints.
- BOULETTE**, in the menage. A horse is called *boulette*, when the fetlock, or postern-joint, bends forward, and out of its natural situation; whether through violent tiding, or by reason of being too short jointed, in which case the least fatigue will bring it.
- BOULOGNE**, or **BLOGNE**, a port-town of France, situated in the province of Picardy, on the English channel: E. long. 1° 30', and N. lat. 50° 40'.
- BOULTINE**, a term which workmen use for a moulding, the convexity of which is just one fourth of a circle, being the member next below the plinth in the Tuscan and Doric capital.
- BOUNCE**, in ichthyology, the English name of a species of squalus. See **SQUALUS**.
- BOUNDS of lands**. See **ABUTTALS**.
- BOUNTY**, in commerce, a premium paid by the government to the exporters of certain British commodities, as sail-cloth, gold and silver lace, silk stockings, fish, corn, &c.
- The happy influence which bounties have on trade and manufactures is well known: Nor can there be a more convincing proof of the good intentions of the government under which we live, than the great care that is taken to give all possible encouragement to those who shall establish, or improve, any hazardous branch of trade.
- BOURBON**, or **MASCARENHA**, an island in the Indian ocean, about one hundred miles east of Madagascar, and subject to France: E. long. 54°, and S. lat. 21°.
- BOURBON-ARCHEBAUT**, the capital of the duchy of Bourbon, in the Lyonois, in France: E. long. 3° 10', and N. lat. 46° 35'.
- BOURBON-LANCY**, a town of Burgundy, in France; in 3° 46' E. long. and 46° 33' N. lat.
- BOURBOURG**, or **BOURBORCH**, a town of the French Netherlands, about 10 miles south-west of Dunkirk; in 2° 10' E. long. and 50° 50' N. lat.
- BOURDEAUX**, the capital of all Guienne and Gascony, situated on the river Garonne, in 40' W. long. and 44° 50' N. lat.
- BOURDINES**, a town of the Austrian Netherlands, 10 miles north-east of Namur; in 5° E. long. and 50° 35' N. lat.
- BOURDONE'E**, in heraldry, the same with pomée. See **POMÉE**.
- BOURG**, the capital of the island of Cayenne, a French colony on the coast of Guiana, in South America; in 52° W. long. and 5° N. lat.
- BOURG-EN-BRESS**, the capital of Bresse, in the province of Burgundy, in France, 36 miles W. of Geneva, and 32 north of Lyons; in 5° 5' E. long. 46° 20' N. lat.
- BOURG-SUR-MER**, a town of Guienne, in France, 15 miles north of Bourdeaux, in 3° W. long.
- BOURGES**, the capital of the territory of Berry, in the Orleansois, in France, situated about 50 miles south-east of Orleans; in 2° 30' W. long. and 47° 10' N. lat.
- BOURGET**, a town of Savoy, six miles north of Chambery; 5° 55' E. long. and 45° 45' N. lat.
- BOURIGNONISTS**, the name of a sect among the Low Country Protestants, being such as follow the doctrine of Antoinette Bourignon, a native of Lisle, an apostate of the Roman Catholic religion.
- The principles of this sect bear a very near resemblance to those of the Quietists or Quakers.
- BOURO**, an island in the Indian Ocean, subject to the Dutch; E. long. 124°, and S. lat. 3° 30'.
- BOUT**, in the manege. A horse is said to be a-bout, when he is overdone, and quite spent with fatigue.
- BOUTANT**, or **ARCH-BOUTANT**, in architecture, an arch, or part of an arch, abutting against the reins of a vault to prevent its giving way.
- A pillar* **BOUTANT** is a large chain or pile of stone, made to support a wall, terrace, or vault.
- BOUTÉ**, in the menage. A horse is called *bouté*, when his legs are in a straight line from the knee to the coronet: Short-jointed horses are apt to be *bouté*; and, on the other hand, long-jointed horses are not.
- BOUTON**, an island in the Indian Ocean: E. long. 121° 30', and lying between 4° and 5° S. lat.
- BOUVILLON**, a city of Luxemburg, in the Austrian Netherlands, about 40 miles west of Luxemburg: E. long. 5° and N. lat. 49° 55'.
- BOW**, a weapon of offence made of steel, wood, horn, or other elastic substances, which, after being bent by means of a string fastened to its two ends, in returning to its natural state, throws out an arrow with prodigious force.
- The use of the bow is, without all doubt, of the earliest antiquity. It has likewise been the most universal of all weapons, having obtained amongst the most barbarous and remote people, who had the least communication with the rest of mankind.
- The figure of the bow is pretty much the same in all countries, where it has been used; for it has generally two inflexions or bendings, between which, in the place where the arrow is drawn, is a right line. The Grecian bow was in the shape of a  $\pi$ , of which form we meet with many, and generally adorned with gold or silver. The Scythian bow was distinguished

distinguished from the bows of Greece and other nations, by its incurvation, which was so great, as to form an half moon or semicircle. The matter of which bows were made, as well as their size, differed in different countries. The Persians had very great bows made of reeds; and the Indians had also, not only arrows, but bows made of the reeds or canes of that country; the Lycian bows were made of the cornel tree; and those of the Æthiopians, which surpassed all others in magnitude, were made of the palm-tree.

Though it does not appear, that the Romans made use of bows in the infancy of their republic, yet they afterwards admitted them as hostile weapons, and employed auxiliary archers in all their wars.

In drawing the bow, the primitive Grecians did not pull back their hand towards their right ear, according to the fashion of modern ages, and of the ancient Persians, but, placing their bow directly before them, returned their hand upon their right breast. This was also the custom of the Amazons.

The bow is a weapon of offence amongst the inhabitants of Asia, Africa, and America, at this day; and in Europe, before the invention of fire-arms, a part of the infantry were armed with bows. Lewis XI. first abolished the use of them in France, introducing, in their place, the halbard, pike, and broad sword. The long bow was formerly in great vogue in England, and many laws were made to encourage the use of it. The parliament under Henry VII. complained of the disuse of long bows, heretofore the safeguard and defence of this kingdom, and the dread and terror of its enemies.

Bow is also an instrument formerly used at sea for taking the sun's altitude; consisting of a large arch of ninety degrees graduated, a shank or staff, a shade vane, a sight vane, and an horizon vane. It is now out of use.

Bow, among builders, a beam of wood or brass, with three long screws, that direct a lath of wood or steel to any arch; chiefly used in drawing draughts of ships, and projections of the sphere; or where-ever it is requisite to draw large arches.

Bow, in music, a small machine, which, being drawn over the strings of a musical instrument, makes it resound. It is composed of a small stick, to which are fastened eighty or an hundred horse-hairs, and a screw which serves to give these hairs the proper tension. In order that the bow may touch the strings briskly, it is usual to rub the hairs with rosin.

Bow, among artificers, an instrument so called from its figure; in use among gunsmiths, locksmiths, watch-makers, &c. for making a drill go. Among turners, it is the name of that pole fixed to the ceiling, to which they fasten the cord that whirls round the piece to be turned.

Bow-STAVES, imported from the British plantations, are free; if from Ireland, Asia, or Africa, they pay 15 s. 4  $\frac{1}{2}$  d. for every 120; and if from any other country, 1 l. 2 s. 10  $\frac{1}{2}$  d. for the same number.

Bows of a saddle are two pieces of wood laid archwise to receive the upper part of a horse's back, to give the saddle its due form, and to keep it tight.

The fore-bow; which sustains the pommel, is com-

posed of the withers, the breasts, the points or toes, and the corking. See WITHERS, &c.

The hind-bow bears the trousequin or quilted roll. The bows are covered with sinews, that is, with bulks pizzels beaten, and so run all over the bows to make them stronger. Then they are strengthened with bands of iron to keep them tight, and, on the lower side, are nailed on the saddle-straps, with which they make fast the girths.

Bow of a ship, that part which begins at the loof, and compassing ends of the stem, and ends at the sternmost part of the fore-castle.

If a ship have a broad round bow, they call it a bold bow. If she has a narrow thin bow, they say she has a lean bow.

BOW-LINE. See BOWLING.

BOW-PIECES are the pieces of ordinance at the bow of a ship.

Rain-BOW. See RAIN-BOW, and OPTICS.

BOW-BEARER, an inferior officer of the forest, who is sworn to make inquisition of all trespasses against vert or venison, and to attack offenders.

BOWE, a market-town of Devonshire, about twelve miles north-west of Exeter; W. long. 4°, and N. lat. 50° 45'.

BOWELS, in anatomy, the same with intestines. See p. 259, &c.

BOWER, in gardening, a place under covert of trees, differing only from an arbour, as being round or square, and made with a kind of dome or ceiling at top; whereas the arbour is always built long and arched.

BOWER, in the sea-language, the name of an anchor carried at the bow of a ship. There are generally two bowers, called first and second, great and little, or best and small bower. See ANCHOR.

BOWESS, or BOWET, in falconry, a young hawk, when she draws any thing out of her nest, and covets to clamber on the boughs.

BOWGE, or BOUCHE of court. See BOUCHE.

BOWL denotes either a ball of wood, for the use of bowling; or a vessel of capacity, wherein to hold liquors.

Bowls and buckets of wood, imported, pay a duty of 9  $\frac{1}{2}$  d. the dozen; whereof 8  $\frac{1}{2}$  d. is repaid on exporting them.

BOWLDER-stones, small stones, of a roundish figure, and no determinate size, found on the sea-shore and banks or rather channels of rivers.

BOWLING, the art of playing at bowls. The first thing to be observed in bowling is, the right chusing your bowl, which must be suitable to the ground you design to run on. Thus, for close alleys, the flat bowl is the best; for open grounds of advantage, the round biased bowl; and for plain and level swards, the bowl that is as round as a ball. The next is to chuse your ground; and, lastly, to distinguish the risings, fallings, and advantages of the places where you bowl.

BOWLING, or BOW-LINE, in a ship, a rope made fast to the leech or middle part of the outside of the sail: it is fastened by two, three, or four ropes, like a crow's foot,

foot, to as many parts of the sail; only the mizen bow-line is fastened to the lower end of the yard. This rope belongs to all sails, except the sprit-sail and sprit-top-sail. The use of the bow-line is to make the sails stand sharp or close, or by a wind.

Sharp the bow-line, is hale it taught, or pull it hard. Hale up the bow-line, that is, pull it harder forward on. Check or ease, or run up the bow-line, that is, let it be more slack.

**BOWLING-bridles**, are the ropes by which the bow-line is fastened to the leech of the sail.

**BOWLING-knot**, a knot that will not slip, by which the bow-line bridle is fastened to the cringles.

**BOWLING-green**, a kind of parterre, laid with fine turf, designed for the exercise of bowling. See **BOWLING**.

**BOW-net**, among sportsmen. See **NET**.

**Bow-saw**, among artificers. See **SAW**.

**BOWSE**, in the sea-language, signifies as much as to hale or pull. Thus bowling upon a tack, is haling upon a tack. Bowse away, that is, pull away all together.

**BOW-SPRIT**, or **BOLT-SPRIT**, a kind of mast, resting slopewise on the head of the main stern, and having its lower end fastened to the partners of the fore-mast, and farther supported by the fore-stay. It carries the sprit-sail, sprit-top-sail, and jak-staff; and its length is usually the same with that of the fore-mast.

**BOW-SPRIT-LADDER**. See **LADDER**.

**BOWYERS**, artificers whose employment or occupation it is to make bows. There is a company of bowyers in the city of London, first incorporated in 1623.

**BOX**, in its most common acceptation, denotes a small chest or coffer for holding things.

Fire-boxes, or tinder-boxes, pay, on importation, a duty of 3 s. 10 <sup>2</sup>/<sub>100</sub> d. the gross; whereof 3 s. 4 <sup>1</sup>/<sub>2</sub> d. is repaid on exportation. Wooden money-boxes pay 3 s. 7 <sup>8</sup>/<sub>100</sub> d. the gross; whereof 3 s. 2 <sup>8</sup>/<sub>100</sub> d. is repaid on exportation. Nest-boxes pay 11 s. 6 <sup>6</sup>/<sub>100</sub> d. the gross; whereof 10 s. 1 <sup>1</sup>/<sub>2</sub> d. is repaid. Pepper-boxes pay 4 s. 3 <sup>7</sup>/<sub>100</sub> d.; whereof 3 s. 9 <sup>5</sup>/<sub>100</sub> d. is repaid. French boxes, for marmalade or jelly, pay each dozen 3 s. <sup>1</sup>/<sub>100</sub> d.; whereof 1 s. 9 <sup>7</sup>/<sub>100</sub> d. is repaid. Sand-boxes pay 3 s. 10 <sup>2</sup>/<sub>100</sub> d. the gross; whereof 3 s. 4 <sup>1</sup>/<sub>2</sub> d. is repaid. Snuff-boxes, if of wood, pay 2 s. 4 <sup>7</sup>/<sub>100</sub> d. the dozen; whereof 2 s. 1 <sup>8</sup>/<sub>100</sub> d. is repaid: if of horn, they pay 4 s. 5 <sup>4</sup>/<sub>100</sub> d. the dozen; 4 s. 3 <sup>7</sup>/<sub>100</sub> d. being drawn back: if of ivory or tortoise-shell, they pay 9 s. 6 <sup>9</sup>/<sub>100</sub> d. the dozen; whereof 8 s. 7 <sup>1</sup>/<sub>2</sub> d. is drawn back. Soap-boxes pay 7 s. 8 <sup>4</sup>/<sub>100</sub> d. the shock, containing sixty boxes. Spice-boxes pay 1 s. 1 <sup>1</sup>/<sub>100</sub> d. the dozen. Tobacco-boxes, pay 5 s. 9 <sup>1</sup>/<sub>100</sub> d. the gross. Touch-boxes, covered with leather, pay only 6 <sup>2</sup>/<sub>100</sub> d. the dozen; but if the leather be the most valuable part, they pay 6 s. 11 <sup>2</sup>/<sub>100</sub> d. for every 20 s. value upon oath: if covered with velvet, they pay 2 s. 10 <sup>6</sup>/<sub>100</sub> d. the dozen: and if of iron, or other metal gilt, they pay 3 s. 10 <sup>2</sup>/<sub>100</sub> d. the dozen: in all which cases, a proportionable draw-back is allowed.

**Box** is also used for an uncertain quantity or measure: thus a box of quicksilver contains from one to two

hundred weight; a box of prunellas, only 14 pounds; a box of rings for keys, two gros, &c.

**Box of a plough**, the cross-piece in the head of a plough, which supports the two crow-staves. See **PLOUGH**.

**Box**, or **Box TREE**, in botany, the English name of the buxus. See **BUXUS**.

**BOXBERG**, a town of Germany in Franconia, belonging to the elector palatine.

**BOXTEL**, a town of Dutch Brabant, situated on the river Bommel, about eight miles south of Boileduc, in 5° 16' E. long. and 51° 30' N. lat.

**BOXTHUDE**, a town of the duchy of Bremen, in Germany, about fifteen miles west of Hamburg, and subject to the elector of Hanover; E. long. 9° 16', and N. lat. 53° 50'.

**BOYAR**, a term used for a grandee of Russia and Transylvania.

Becman says, that the boyars are the upper nobility; and adds, that the Czar of Muscovy, in his diplomas, names the boyars before the waywodes. See **WAYWODE**.

**BOYAU**, in fortification, a ditch covered with a parapet, which serves as a communication between two trenches. It runs parallel to the works of the body of the place, and serves as a line of contravallation, not only to hinder the sallies of the besieged, but also to secure the miners. But when it is a particular cut that runs from the trenches to cover some spot of ground, it is drawn so as not to be enfiladed, or scoured by the shot from the town.

**BOYER**, a small vessel of burden, resembling a smack, with only one mast and a bolt-sprit.

**BOYES**, idolatrous priests among the savages of Florida.

Every priest attends a particular idol, and the natives address themselves to the priest of that idol to which they intend to pay their devotion.

The idol is invoked in hymns, and his usual offering is the smoke of tobacco.

**BOYNE**, a river of Ireland, which, taking its rise in Queen's county, in the province of Leinster, runs north-east by Trim and Cavan, and falls into the Irish channel, a little below Drogheda.

**BOZOLO**, a town of the duchy of Mantua, about 12 miles south-west of that city; E. long. 11°, and N. lat. 44° 40'.

**B QUADRO**, **QUADRATO**, or **DURALE**, in music, called by the French *b quarrre*, from its figure ♯. This is what we call B natural or sharp, in distinction to B mol or flat. See **FLAT**, and **SHARP**.

If the flat ♭ be placed before a note in the thorough bass, it intimates, that its third is to be minor; and if placed with any cipher over a note in the bass, as ♭6, or ♭5, &c. it denotes, that the fifth or sixth thereto are to be flat. But if the quadro ♯ be placed over any note, or with a cipher, in the thorough bass, it has the contrary effect; for thereby the note or interval thereto is raised to its natural order.

**BRABANT**, a large province of the Netherlands, lying eastward of Flanders; the greater part of it is subject

- to the house of Austria, the capital Brussels; and the rest to the Dutch, their capital Breda.
- BRABEJUM**, in botany, a genus of the tetrandria monogynia class. The corolla is below the fruit, and consists of four petals. It has no calix; the fruit is a hairy drupe, of an oval figure. There is only one species, viz. the stellatiferum, a native of Æthiopia.
- BRABEUTES**, or **BRABEUTA**, in antiquity, an officer among the Greeks, who presided at the public games, and decided controversies that happened among the antagonists in the gymnastical exercises. The number of brabeutes was not fixed; sometimes there was only one, but more commonly they amounted to nine or ten.
- BRACCIANO**, a town of St Peter's patrimony, about twelve miles north of Rome, situated on the west side of a lake, to which it gives name; E. long. 13°, and N. lat. 42°.
- BRACE** is commonly taken for a couple or pair, and applied by huntsmen to several beasts of game, as a brace of bucks, foxes, hares, &c.
- BRACE**, or **BRASSE**, is also a foreign measure, answering to our fathom. See **FATHOM**.
- BRACE**, in architecture, a piece of timber framed in with bevil joints, the use of which is to keep the building from swerving either way. When the brace is framed into the kingleaves or principal rafters, it is by some called a strut.
- BRACES**, in the sea-language, are ropes belonging to all the yards of a ship, except the mizen, two to each yard, reeved through blocks that are fastened to pennants, seized to the yard-arms. Their use is either to square, or traverse the yards. Hence to brace the yard, is to bring it to either side. All braces come aftward on, as the main brace comes to the poop, the main-top-sail brace comes to the mizen-top, and thence to the main shrouds: The fore and fore-top-sail braces come down by the main and main-top-sail stays, and so of the rest. But the mizen-bowline serves to brace to the yard, and the cross-jack braces are brought forwards to the main shrouds, when the ship sails close by a wind.
- BRACED**, in heraldry, a term for the intermingling three chequerons. See Plate LI. fig. 18.
- BRACELET**, an ornament worn on the wrist, much used among the ancients: It was made of different materials, and in different fashions, according to the age and quality of the wearer.
- Bracelets are still worn by the savages of Africa, who are so excessively fond of them, as to give the richest commodities, and even their fathers, wives, and children, in exchange for those made of no richer materials than shells, glass, beads, and the like.
- Bracelets of glass pay 3s. 8 $\frac{1}{2}$ d. the small gross, containing twelve bundles or dickers; and, if of the French manufacture, they pay 4s. 1 $\frac{3}{4}$ d. for the same quantity: A proportionable drawback is allowed in each case.
- BRACHIÆUS**, in anatomy, the name of a muscle. See p. 197.
- Coraco-BRACHIALIS**, in anatomy, the name of a muscle. See p. 196.
- BRACHIONUS**, in zoology. See **LABELLA**.
- BRACHIUM**, or **ARM**, in anatomy, one of the superior extremities of the human body, comprehending the **SCAPULA**, the **OS HUMERI**, the **CUBIT**, and the **HAND**. See these articles.
- BRACHMINS**, a sect of Indian philosophers known to the ancient Greeks by the name of *Gymnosophists*. The ancient brachmins lived upon herbs and pulse, and abstained from every thing that had life in it. They lived in solitude without matrimony, and without property: and they wished ardently for death, considering life only as a burden. The modern brachmans make up one of the casts or tribes of the banians. They are the priests of that people, and perform their office of praying and reading the law, with several mimical gestures, and a kind of quavering voice. They believe, that, in the beginning, nothing but God and the water existed, and that the supreme Being, desirous to create the world, caused the leaf of a tree, in the shape of a child playing with its great toe in its mouth, to float on the water. From its navel there issued out a flower, whence Brama drew his original, who was intrusted by God with the creation of the world, and presides over it with an absolute sway. They make no distinction between the souls of men and brutes, but say the dignity of the human soul consists in being placed in a better body, and having more room to display its faculties. They allow of rewards and punishments after this life; and have so great a veneration for cows, that they look on themselves as blessed, if they can but die with the tail of one of them in their hand. They have preserved some noble fragments of the knowledge of the ancient brachmans. They are skilful arithmeticians, and calculate, with great exactness, eclipses of the sun and moon. They are remarkable for their religious austerities. One of them has been known to make a vow, to wear about his neck a heavy collar of iron for a considerable time: Another to chain himself by the foot to a tree, with a firm resolution to die in that place: And another to walk in wooden shoes, stuck full of nails on the inside. Their divine worship consists chiefly of processions, made in honour of their deities. They have a college at Banara, a city seated on the Ganges.
- BRACHYGRAPHY**, the art of short-hand writing. See **SHORT-HAND**.
- BRACHYPTERA**, a term used by Willoughby, to denote those hawks which have their wings so short, as not to reach to the end of the tail: Of this kind are the goshawk, sparrow-hawk, &c.
- BRACHYPYRENIA**, in the history of fossils, a genus of septaria, with a short roundish nucleus. See **SEPTARIAE**.
- BRACHYTELOSTYLA**, in natural history, the name by which Dr Hill calls those crystals, which are composed of a short hexangular column, terminated at each end by an hexangular pyramid. See **CRYSTAL**.
- BRACKET**, among carpenters, &c. a kind of wooden stay, serving to support shelves, and the like.

BRACK-



**BRACKETS**, in a ship, the small knees, serving to support the galleries, and commonly carved. Also the timbers that support the gratings in the head, are called brackets.

**BRACKETS**, in gunnery, are the cheeks of the carriage of a mortar: they are made of strong planks of wood, of almost a semicircular figure, and bound round with thick iron plates; they are fixed to the beds by four bolts, which are called bed-bolts; they rise up on each side of the mortar, and serve to keep her at any elevation, by means of some strong iron bolts, called bracket-bolts, which go through these cheeks or brackets.

**BRACKLAW**, the capital of the palatinate of Bracklaw, in Podolia, in Poland, situated on the river Bog, an hundred and ten miles east of Kaminec: E. long.  $29^{\circ} 20'$ , and N. lat.  $48^{\circ}$ .

**BRACKLEY**, a borough-town of Northamptonshire; about fifteen miles south-west of Northampton: W. lon.  $1^{\circ} 15'$ , and N. lat.  $52^{\circ}$ .

It sends two members to parliament.

**BRACTEA**, in natural history, denotes a spangle, or thin flake of any substance.

**BRACTEA**, in botany. See **FLORAL LEAF**.

**BRACTEARIA**, in natural history, a genus of tales, composed of small plates in form of spangles, each plate either being very thin, or fissile into very thin ones.

Of this genus there are a great many species, called, from their different colours, *mica aurea*, or gold-glimmer; and *mica argentea*, silver-glimmer, or catsilver, &c.

**BRAD**, in geography, a town of Sclavonia, situated on the north side of the river Save, eighteen miles south of Pofega: E. long.  $18^{\circ} 40'$ , and N. lat.  $45^{\circ} 20'$ .

**BRADFIELD**, a market-town in Essex, fourteen miles north of Chelmsford: E. long.  $30'$ , and N. lat.  $51^{\circ} 54'$ .

**BRADFORD**, a market-town in Wiltshire, about nine miles west of the Devizes: E. long.  $2^{\circ} 40'$ , and N. lat.  $51^{\circ} 20'$ .

**BRADFORTH**, a market-town of Yorkshire, thirty miles south-west of York: W. long.  $1^{\circ} 35'$ , and N. lat.  $53^{\circ} 40'$ .

**BRADNICH**, a market town of Devonshire, ten miles north of Exeter: W. long.  $3^{\circ} 35'$ , and N. lat.  $50^{\circ} 45'$ .

**BRADS**, among artificers, a kind of nails used in building, which have no spreading heads, as other nails have. They are distinguished, by iron-mongers, by six names, as joiner's-brads, flooring brads, batten-brads, bill-brads, or quarter heads, &c. Joiner's-brads are for hard wainscot, batten brads are for soft wainscot; bill-brads are used when a floor is laid in haste, or for shallow joists subject to warp. See **NAIL**.

**BRADYPUS**, or sloth, a genus of quadrupeds belonging to the order of bruta. The characters are these: They have no fore-teeth in either jaw; the dog-teeth are blunt, solitary, and longer than the grinders; they have five grinders on each side. The body is covered with hair. There are only two species of bradypus, viz. 1. The tridactylis, or American

sloth, has a short tail, and only three toes on each foot. It is about the size of a fox. The body is covered over with hair of a grey colour; the face is naked; the throat is yellowish; the fore-feet are longer than the hind-feet; the claws, which are three on each foot, are compressed, and very strong; and they have no mammæ on the breast; they have no external ears, but only two winding holes. This species is a native of America, and feeds upon the tender leaves of trees, and particularly the leaves of the cecropia. It never drinks, and is terrified at rain. It climbs trees with great ease; but its motion on the ground is so slow, that it can hardly walk fifty paces in a day, and from this circumstance it is called a *Sloth*. It makes a most disagreeable noise, resembling that of a young cat. See Plate LIX. fig. 1. 2. The didactylus, or Ceylon sloth, has two toes on each foot, and no tail: The head is round; the ears are large; and it has two mammæ on the breast: The body is covered with ash-coloured hair. It has the same disagreeable cry with the American sloth, and is a native of Ceylon.

**BRAG**, an ingenious and pleasant game at cards, where as many may partake as the cards will supply; the eldest hand dealing three to each person at one time, and turning up the last card all round. This done, each gamester puts down three stakes, one for each card. The first stake is won by the best card turned up in the dealing round; beginning from the ace, king, queen, knave, and so downwards. When cards of the same value are turned up to two or more of the gamesters, the eldest hand gains; but it is to be observed, that the ace of diamonds wins, to whatever hand it be turned up.

The second stake is won by what is called the brag, which consists in one of the gamesters challenging the rest to produce cards equal to his: Now it is to be observed, that a pair of aces is the best brag, a pair of kings the next, and so on; and a pair of any sort wins the stake from the most valuable single card. In this part consists the great diversion of the game; for, by the artful management of the looks, gestures, and voice, it frequently happens, that a pair of fives, treys, or even duces, out-brags a much higher pair, and even some pairs royal, to the no small merriment of the company. The knave of clubs is here a principal favourite, making a pair with any other card in hand, and with any other two cards a pair royal.

The third stake is won by the person who first makes up the cards in his hand one and thirty; each dignified card going for ten, and drawing from the pack, as usual in this game.

**BRAGA**, the capital of the province of Entre-minhorduro, in Portugal, situated on the river Cavado, 32 miles north of Porto; W. long.  $8^{\circ} 40'$ , and N. lat.  $41^{\circ} 20'$ .

**BRAGANZA**, a city of the province of Tralofmontes, in Portugal, situated on the river Sabor, in  $7^{\circ}$  W. long. and  $41^{\circ} 50'$  N. lat.

**BRAGGET**, a kind of drink made of malt, honey, and spices, much used in Wales.

**BRAIL**, or **BRAILS**, in a ship, are small ropes made

use of to furl the sails across: They belong only to the two courses and the mizen-sail; they are reeved through the blocks, seized on each side the ties, and come down before the sail, being at the very skirt thereof fastened to the cringles; their use is, when the sail is furled across, to hale up its bunt, that it may the more easily be taken up or let fall. Hale up the brails, or brail up the sail, that is, hale up the sail, in order to be furled or bound close to the yard.

**BRAILOW**, a town of Podolia, in Poland, situated on the river Bog, 40 miles north of Bracklow; E. long. 29°, and N. lat. 48° 50'.

**BRAIN**, in anatomy. See p. 283, &c.

**BRAIN LE COMPTE**, a town of Hainalt, in the Austrian Netherlands, fifteen miles south-east of Brussels, and nine north-east of Mons; E. long. 4°, and N. lat. 50° 40'.

**BRAINTREE**, a market-town of Essex, 12 miles north of Chelmsford; E. long. 35', and N. lat. 51° 50'.

**BRAKE** denotes female fern, or the place where it grows: Also a sharp bit or snaffle for horses; and a baker's kneading trough: Also an instrument with teeth, to bruise flax or hemp.

**BRAKEL**, a town of the bishopric of Paderborn, in the circle of Westphalia, in Germany; E. long. 9°, and N. lat. 51° 40'.

**BRALROENS**, one of the Sunda-islands, lying north-east of Java, in 4° 30' N. lat.

**BRAMA**, in ichthyology, the trivial name of a species of cyprinus. See **CYPRINUS**.

**BRAMANT**, a town of Savoy, 35 miles north-west of Turin; E. long. 6° 45', and N. lat. 45°.

**BRAMBER**, a borough-town of Suffex, about 16 miles south-east of Grinstead; W. long. 15', and N. lat. 50° 50'. It sends two members to parliament.

**BRAMBLE**, or **BRAMBLE-BUSH**, in botany, the English name of the rubus. See **RUBUS**.

**BRAMBLE-NET**, otherwise called hallier, is a net to catch birds in, of several sizes; the great meshes must be four inches square; those of the least size are three or four inches square; and those of the biggest five. In the depth, they should not be above three or four inches; but as for the length, they may be enlarged at pleasure; the shortest being eighteen feet long.

**BRAMBLE**, or **BRAMBLING**, in ornithology, the English name of a species of fringilla. See **FRINGILLA**.

**BRAMINS**, the name of the priests among the idolatrous Indians; the successors of the ancient brachmans. See **BRACHMANS**.

**BRAMPORE**, a town of the Hither Peninsula of India; E. long. 77°, and N. lat. 21° 30'.

**BRAMPTON**, a market-town of Cumberland, about six miles north-east of Carlisle; W. long. 2° 40', and N. lat. 54° 50'.

**BRAMYARD**, a market-town of Herefordshire, about 12 miles north-east of Hereford; W. long. 2° 30', and N. lat. 52° 20'.

**BRAN**, the skins or husks of corn, especially wheat ground, separated from the flour by a sieve or boulder.

It is of wheat-bran that starch-makers make their starch. The dyers reckon bran among the not-co-

louring drugs, and use it for making, what they call, *the four waters*, with which they prepare their several dyes.

**BRANCH**; in botany, an arm of a tree, or a part, which, sprouting out from the trunk, helps to form the head or crown thereof.

**BRANCHES of a bridle**, in the manege, are two pieces of iron bended, which, in the interval, between the one and the other, bear the bit-mouth, the cross-chains, and the curb; so that on one end they answer to the head-stall, and on the other to the reins, in order to keep the horse's head in subjection. With regard to their form and structure, branches are either strait, in form of a pistol, for young horses to form their mouth; or, after the constable of France's fashion, proper for a horse that carries his head well. Some are in form of a gigot or leg, which will prevent horses from carrying too low: Some in form of a bent knee, contrived for horses that arm themselves against the operation of the bit; and others after the French fashion, which is hardly about  $\frac{1}{4}$  of an inch at the sevile hole, and kneed  $1\frac{1}{2}$  inch at the jarret or ham.

It is to be observed, 1. That the farther the branch is from an horse's neck, the more effect it will have. 2. That short branches, *cæteris paribus*, are ruder, and their effects more sudden, than those of longer. 3. That the branch is to be proportioned to the length of a horse's neck; and one may sooner err in chusing one too short than too long.

**BRANCHES of ogives**, in architecture, are the arches of Gothic vaults. These arches traversing from one angle to another diagonal wise, form a cross between the other arches, which make the sides of the square, of which the arches are diagonals.

**BRANCH of a trench**. See **BOYAU**.

**BRANCH of a mine**. See **GALLERY**.

**BRANCH-STAND**, with falconers, a term used to signify the making a hawk leap from tree to tree, till the dog springs the game.

**BRANCHER**, among sportsmen, a young hawk, newly taken out of the nest, that can hop from bough to bough.

**BRANCHIÆ**, or **GILLS**, in the anatomy of fishes, the parts corresponding to the lungs of land-animals, by which fishes take in and throw out again a certain quantity of water, impregnated with air. All fishes, except the cetaceous ones and the petromyzum, are furnished with these organs of respiration; which are always eight in number, four on each side the throat. That next the heart is always the least, the rest increasing in order as they stand near the head of the fish.

Each of these gills is composed of a bony lamina, in form of a semicircle, for the most part; and on its convex side stand the leaves or lamellæ, like so many sickles. The whole convex part of the lamellæ is beset with hairs, which are longest near the base, and decrease gradually as they approach towards the point. There are also hairs on the concave side of the lamellæ, but shorter than the others, and continued only to its middle.

The

The convex side of one lamina is fitted into the concave side of the next superior one; and all of them are connected together by means of a membrane, which reaches from their base half-way their height, where it grows thicker, and in some measure resembles a rope. The rest of the lamina is free, and terminates in a very fine and flexible point.

As to the use of these gills, they seem to be designed to receive the blood protruded from the heart into the aorta, and convey it into the extremities of the lamellæ; from whence being returned by veins, it is distributed over the body of the fish.

**BRANCHIARUM** *foramina*, apertures of the gills. In most fishes there is only one aperture; in the cartilaginous ones, these apertures are ten in number, five on each side; and in the petromyzon or lamprey, there are no less than fourteen of these apertures, seven on each side.

As to the cetaceous fishes, they have no aperture of this kind; and the reason seems to be, because they are furnished with lungs.

**BRANCHIDÆ**, in Grecian antiquity, priests of the temple of Apollo, which was at Dydimus in Ionia, a province of lesser Asia, towards the Ægean sea, upon the frontiers of Caria. They opened to Xerxes the temple of Apollo, the riches whereof he took away. After which, thinking it unsafe to stay in Greece, they fled to Sogdiana, on the other side of the Caspian sea, upon the frontiers of Persia, where they built a city, called by their own name; but they did not escape the punishment of their crime: For Alexander the Great having conquered Darius king of Persia, and being informed of their treachery, put them all to the sword, and razed their city, thus punishing the impiety of the fathers in their posterity.

**BRANCHON**, a town of the Austrian Netherlands, about eight miles north of Namur: E. long. 4° 50', and N. lat. 50° 32'.

**BRANCHUS**, a defluxion of humours upon the fauces, being a species of catarrh.

**BRANDEIS**, a town of Bohemia, situated on the river Elbe, ten miles north-east of Prague: E. long. 14° 25', N. lat. 50° 15'.

**BRANDENBURG**, a city of the marquisate of Brandenburg in Germany, situated on the river Havel, twenty-six miles west of Berlin: E. long. 13°, N. lat. 52° 25'.

It was once the capital of Brandenburg; but is now on the decline, since Berlin supplanted it.

**BRANDON**, a market-town of Suffolk, ten miles north of Bury: E. long. 45', N. lat. 52° 30'.

It gives the title of duke to his grace the duke of Hamilton.

**BRANDRITH**, a trevet, or other iron-utensil, to set a vessel on over the fire.

**BRANDY**, a spirituous and inflammable liquor, extracted from wine and other liquors, by distillation. See *CHEMISTRY, Of spirituous fermentation, and distilling.*

Wine-brandy, made in France, is esteemed the best in Europe. They make it where-ever they make wine,

and for that purpose use wine that is pricked rather than good wine. The chief brandies for foreign trade, and those accounted best, are the brandies of Bourdeaux, Rochelle, Cogniac, Charenton, the isle of Rhe, Orleans, the county of Blaisois, Poitou, Touraine, Anjou, Nantes, Burgundy, and Champagne.

**BRANLIN**, in ichthyology, a species of salmon, with several transverse black streaks, resembling the impression of so many fingers.

**BRANSKA**, a town of Transylvania, situated on the river Marish: E. long. 23° 15', and N. lat. 46°.

**BRASEM**, in ichthyology, a fish otherwise called *acara-peba*.

**BRASIDIA**, an anniversary solemnity at Sparta, in memory of Brasidas, a Lacedæmonian captain, famous for his achievements at Methone, Pylos, and Amphipolis. It was celebrated with sacrifices and games, wherein none were permitted to contend, but free-born Spartans. Whoever neglected to be present at the solemnity was fined.

**BRASIL**, or **BRAZIL**, a large maritime country of South America, lying between 35° and 60° W. lon. and between the equator and 35° S. lat.

It is bounded by the Atlantic ocean and the river Amazon on the north, by the same ocean on the east, by the river of Plate on the south, and by Paraguay on the west; being computed to be 2500 miles in length, and 700 miles in breadth. The Portuguese have now the sole dominion of this extensive country, where, besides sugar and tobacco, there are rich mines of gold and diamonds; from whence his Portuguese majesty draws a very considerable revenue.

**BRASIL wood**, or **BRAZIL-wood**, an American wood of a red colour, and very heavy. It is denominated variously, according to the places from whence it is brought: Thus we have brasil from Fernambuco, Japan, Lamon, &c.

The brasil-tree ordinarily grows in dry barren places, and even in the cliffs of rocks: It is very thick and large, usually crooked and knotty: Its flowers, which are of a beautiful red, exhale a very agreeable smell.

Though the tree be very thick, it is covered with so gross a bark, that when the savages have taken it off, the wood or trunk, which was before the thickness of a man, is scarce left equal to that of his leg.

This wood must be chosen in thick pieces, close, sound, without any bark on it, and such as, upon splitting, of pale becomes reddish, and, when chewed, has a saccharine taste. It is much used in turned work, and takes a good polish: But its chief use is in dyeing, where it serves for a red colour: It is a spurious colour, however, that it gives, and easily evaporates and fades; nor is the wood to be used without alum and tartar. From the Brasil of Fernambuco, is drawn a kind of carmine, by means of acids: There is also a liquid lacca made of it, for miniature.

**BRASLAW**, the capital of a palatinate of the same name, in the province of Lithuania in Poland: E. lon. 26°, N. lat. 56° 20'.

**BRASS**, or, as the French call it, *yellow copper*, is a factitious metal, made of copper and zinc, or lapis calaminaris. See **CHEMISTRY**, *Of zinc*.

**Corinthian BRASS** has been famous in antiquity, and is a mixture of gold, silver, and copper. L. Mummius having sacked and burnt the city of Corinth, 146 years before Christ, it is said this metal was formed from the immense quantities of gold, silver and copper wherewith that city abounded, thus melted and run together by the violence of the conflagration.

**BRASS-colour**, one prepared by the braziers and colourmen to imitate brass. There are two sorts of it, the red brass, or bronze, and the yellow or gilt brass: The latter is made only of copper-filings, the smallest and brightest that can be found; with the former they mix some red ochre, finely pulverized; they are both used with varnish.

**BRASSE**, in ichthyology, the English name of the *perca lucio-perca*. See **PERCA**.

**BRASSICA**, or **CABBAGE**, in botany, a genus of the tetradynamia siliquosa class. The calix is erect and connivent; the seeds are globular; and there is a nectariferous gland between the pistillum and the short stamina, and between the calix and the long stamina. There are ten species of this plant, most of which are excellent pot-herbs, and cultivated in our gardens.

**BRASSICAVIT**, or **BRACHICAVIT**, in the menage, is a horse whose fore-legs are naturally bended archwise: being so called by way of distinction from an arched horse, whose legs are bowed by hard labour.

**BRAVA**, or *Paraíra-BRAVA*. See **PARREIRA BRAVA**.

**BRAULS**, Indian cloths with blue and white stripes. They are otherwise called turbants, because they serve to cover those ornaments of the head, particularly on the coast of Africa.

**BRAUNAU**, or **BRANAU**, a town of Bavaria in Germany, about twenty-five miles south-west of Passau.

**BRAUNSBURG**, a town of Prussia, situated on the Baltic sea, about thirty miles south-west of Königsburg: E. long. 20°, N. lat. 54° 15'.

**BRAVO**, one of the Cape verd islands: W. long. 25°, N. lat. 14°.

**BRAURONIA**, in Grecian antiquity, a festival in honour of Diana, surnamed *Brauronia*, from its having been observed at Brauron, an Athenian borough.

This festival was celebrated once in five years, being managed by ten men, called, in Greek, [*ieropoioi*]. The victim offered in sacrifice was a goat, and it was customary for certain men to sing one of Homer's iliads. The most remarkable persons at this solemnity were young virgins, habited in yellow gowns, and consecrated to Diana. It was unlawful for any of them to be above ten, or under five years of age.

**BRAWN**, the flesh of a boar souced or pickled; for which end the boar should be old; because the older he is, the more horny will the brawn be.

The method of preparing brawn is as follows: The boar being killed, it is the stitches only, without the legs, that are made brawn; the bones of which are to be taken out, and then the flesh sprinkled with salt, and laid in a tray, that the blood may drain off: Then

it is to be salted a little, and rolled up as hard as possible. The length of the collar of brawn, should be as much as one side of the boar will bear; so that when rolled up, it will be nine or ten inches diameter.

The collar being thus rolled up; is to be boiled in a copper, or large kettle, till it is so tender, that you can run a straw through it; then set it by, till it is thorough cold, and put it into the following pickle. To every gallon of water, put a handful or two of salt, and as much wheat bran: Boil them together, then drain the bran as clear as you can from the liquor; and when the liquor is quite cold, put the brawn into it.

**BRAY**, a town of Champaign in France, about 16 miles north of Sens: E. long. 3° 20', N. lat. 48° 25'.

**BRAY** is also the name of a port town of the county of Wicklow, and province of Leinster, in Ireland; W. long. 6° 16', N. lat. 53° 12'.

**BRAYLE**, among sportsmen, a piece of leather slit to put upon the hawk's wing, to tie it up.

**BRAZED**, in heraldry, a term serving to describe three cheverons, one clasping another.

**BRAZEN**, something consisting of brass, or formed out of it. See **BRASS**.

**BRAZIER**, an artificer who makes or deals in all kinds of brass-ware.

**BRAZIL**. See **BRASIL**.

**BRAZING**, the folding or joining two pieces of iron together by means of thin plates of brass, melted between the pieces that are to be joined. If the work be very fine, as when two leaves of a broken saw are to be brazed together, they cover it with pulverized borax, melted with water, that it may incorporate with the brass powder, which is added to it: The piece is then exposed to the fire without touching the coals, and heated till the brass is seen to run.

**BRAZING** is also the joining two pieces of iron together by beating them hot, the one upon the other, which is used for large pieces by farriers, &c.

**BRAZZA**, a town and island on the coast of Dalmatia, in the Gulph of Venice; E. long. 18°, N. lat. 43°.

**BREACH**, in fortification, a gape made in any part of the works of a town by the cannon or mines of the besiegers, in order to make an attack upon the place. To make the attack more difficult, the besieged sow the breach with crow-feet, or stop it with chevaux de frize.

A practicable breach, is that where the men may mount and make a lodgement, and ought to be fifteen or twenty fathoms wide. The besiegers make their way to it, by covering themselves with gabions, earth-bags, &c.

**BREACH**, in a legal sense, is where a person breaks through the condition of a bond or covenant; or an action upon which, the breach must be assigned: And this assignment must not be general, but particular; as, in an action of covenant for not repairing houses, it ought to be assigned particularly what is the want of reparation; and in such certain manner, that the defendant may take an issue.

**BREAD**,

**BREAD**, a mass of dough, kneaded and baked in an oven. See **BAKING**.

Bread ought to be well kneaded, and seasoned with a little salt, otherwise it is accounted very unwholesome.

We find bread sometimes made of rye, oats, barley, or vetch-flour; but of all others, that prepared from wheat affords the most wholesome nourishment. In several parts of Asia, Africa, and America, they make bread of maiz-flour; besides which, the Americans make bread of the cassava-root. See **CASSAVA**.

Some are of opinion, that corn growing in gravelly and light lands, makes better bread than that which grows in deep and low grounds.

**French-BREAD**. To make good French bread, for every two quarts of flour, add six spoonfuls of ale-yeast; also milk and water, warmed; a bit of butter, and a little salt; make them pretty light, and letting them rise before the fire, bake them in a quick oven.

Some put the yolks of six eggs, and the whites of two, to this quantity; but others think the bread better without them.

Foreign bread, or bisket, pays duty on importation 1s. 7<sup>1</sup>/<sub>2</sub>d. for every 112lb. whereof 1s. 5<sup>1</sup>/<sub>2</sub>d. is repaid on exporting it again.

**BREAD-ROOM**, in a ship, that destined to hold the bread, or bisket.

The boards of the bread-room should be well jointed and caulked, and even lined with tin plates, or mats. It is also proper to warm it well with charcoal, for several days before the bisket is put into it; since nothing is more injurious to the bread than moisture.

**BREAD**, in scripture style, is taken for every sort of food. The ancient Hebrews had several ways of baking bread, as baking it under the ashes, between two fires made of cow-dung, and in an oven. The Jews had, besides their leavened and unleavened bread, their shew-bread, bread of affliction, &c. See the articles **LEAVENED**, &c.

**BREADTH**, in geometry, one of the three dimensions of bodies, which multiplied into their length constitutes a surface.

**BREAK**, in a general sense, signifies to divide a thing into several parts with violence.

In the art of war, to break ground, is to open the trenches before a place.

Among sportsmen, to break a horse in trotting, is to make him light upon the hand in trotting, in order to make him fit for a gallop. To break a horse for hunting, is to supple him, to make him take the habit of running.

**BREAKING**, in a mercantile style, denotes the not paying one's bills of exchange, accepted, or other promissory notes, when due; and ascending, to avoid the severity of one's creditors. In which sense, breaking is the same with becoming bankrupt. See **BANKRUPT**.

**BREAKING BULK**, in the sea language, is the same with unloading part of the cargo.

**BREAM**, in ichthyology, the English name of the cyprinus brama. See **CYPRINUS**.

**BREAST**, in anatomy, denotes the fore-parts of the thorax. See **ANATOMY**, p. 227.

**BREASTS**, or **MAMMÆ**, in anatomy. See **ANATOMY**, p. 227.

**BREAST-PLATE**, in antiquity, a piece of armour worn to defend the breast, originally believed to be made of hides, or hemp twilled into small cords, but afterwards made of brass, iron, or other metals, which were sometimes so exquisitely hardened, as to be proof against the greatest force.

**BREAST-PLATE**, in the menage, the strap of leather that runs from one side of the saddle to the other, over the horse's breast, in order to keep the saddle tight, and hinder it from sliding backwards.

**BREAST-PLOUGH**, one so fashioned that a man may shove it before him.

**BREAST-WORK** the same with parapet. See **PARAPET**.

**BREATH**, the air inspired and expelled again in the action of respiration.

**BREATH**, or **WIND**, in the menage, sometimes signifies the easy respiration of an horse, and sometimes it implies the ease and rest or repose of a horse; as, give your horse breath, that is, do not ride him down; give that leaping horse a long breathing-time between the turns or repetitions of his menage, &c.

**BREATHING**, the same with respiration.

**BRECHIN**, a borough-town of the county of Angus in Scotland, about 15 miles north-east of Dundee; W. long. 2° 20', north lat. 56° 40'.

**BRECON**, or **BRECKNOCK**, a borough-town of Brecknockshire, in Wales; W. long. 3° 25', N. lat. 52°.

**BREDA**, the capital of Dutch Brabant, about 30 miles north-east of Antwerp; E. long. 4° 40', N. lat. 51° 40'. It is a strong fortified town.

**BREECHES**, a kind of close garment or covering for the thighs, hips, &c. worn by the modern Europeans.

The breeches are peculiar to the male sex, and answer, in some measure, to the femoralia of the Romans.

**BREECH** of a great gun, or cannon, the end next the touch-hole.

**BREECHINGS**, in the sea-language, the ropes with which the great guns are lashed, or fastened to the ship's side.

They are thus called, because made to pass round the breech of the gun.

**BREEDING**, in a general sense, the producing, nourishing, and educating all manner of young animals.

**BREEDING of horses**. See **EQUUS**.

**BREEZE**, a shifting wind, that blows from sea or land for some certain hours in the day or night; common in Africa and some parts of the E. and W. Indies.

The sea-breeze is only sensible near the coasts; it commonly rises in the morning, about nine, proceeding slowly in a fine small black curl on the water, towards the shore; it increases gradually till twelve, and dies about five. Upon its ceasing, the land-breeze commences, which increases till twelve at night, and is succeeded in the morning by the sea-breeze again.

**BREEZE**, in brick-making, small ashes and cinders, sometimes made use of instead of coals, for the burning of bricks: But as this does not so well answer the end, the use of it is prohibited by 12 George I. cap. xxxv.

**BREEZE**,

**BREEZE**, is also the name of an insect, called the gad-fly, or horse-fly. See **FLY**.

**BREGENTS**, or **BERGENTS**, a town situated at the east end of the lake of Constance, in the county of Tyrol in Germany; E. long.  $9^{\circ} 40'$ , and N. lat.  $47^{\circ} 26'$ .

**BREGMA**, in anatomy, the same with sinciput. See **ANATOMY**, p. 154.

**BREIDEWICK**, a cape on the south-west of Iceland, in the northern ocean.

**BREMEN**, the capital of the duchy of the same name, in Lower Saxony, situated on the river Weser, in  $8^{\circ} 20'$  E. long. and  $53^{\circ} 25'$  N. lat.  
This city and duchy belongs to the king of Great Britain, as elector of Hanover.

**BREMERVHOIDE**, a fortified town of the duchy of Bremen, about seventeen miles north of Bremen; E. long.  $8^{\circ} 35'$ , and N. lat.  $53^{\circ} 48'$ .

**BREMGARTEN**, a town of Switzerland, in the county of Baden, about twelve miles west of Zurich; E. long.  $8^{\circ} 15'$ , and N. lat.  $47^{\circ} 20'$ .

**BREMGINGHAM**, in geography. See **BIRMINGHAM**.

**BRENBURG**, in geography. See **BERNBURG**.

**BRENT**, in geography, a market town of Devonshire, situated twenty-seven miles south-west of Exeter; W. long.  $4^{\circ} 7'$ , and N. lat.  $50^{\circ} 30'$ .

**BRENT-POOLE**, a species of goose with a black neck, and a white collar round; usually confounded with the barnacle, though in reality a distinct species.  
It is a little larger than the common duck, and is described by authors under the name of *anas torquata*.

**BRENTA**, a liquid measure used at Rome.

**BRENTE**, in geography, a river which, taking its rise in the bishopric of Trent, in Germany, runs south-east through the Venetian territories, and falls into the Adriatic sea, opposite to Venice.

**BRENTFORD**, a market-town of Middlesex, about seven miles west of London; W. long.  $7'$ , and N. lat.  $51^{\circ} 26'$ .

**BRENTWOOD**, or **BURNTWOOD**, a market-town of Essex, about fifteen miles east of London; E. long.  $15'$ , and N. lat.  $51^{\circ} 35'$ .

**BREPHOTROPHIUM**, an hospital for the maintenance of children; not unlike our foundling-hospital. See **HOSPITAL**.

**BRESCIA**, a city of Italy, about thirty miles north of Cremona; E. long.  $10^{\circ} 35'$ , and N. lat.  $45^{\circ} 30'$ .  
It is a bishop's see, and subject to Venice.

**BRESELLO**, a town of the duchy of Modena, in Italy, situated on the southern shore of the river Po, about twenty-five miles north-west of Modena; E. long.  $11^{\circ}$ , and N. lat.  $44^{\circ} 46'$ .

**BRESICATE**, in commerce, a kind of bays, of which there is some trade carried on with the negroes, between the river Gambia and Sierra Leone. The best sorts for that purpose are the blue and the red.

**BRESLAW**, the capital of Silesia, situated upon the river Oder, in  $16^{\circ} 50'$  E. long. and  $51^{\circ} 15'$  N. lat.

**BRESMA**, in ichthyology, a name used by some for the bream. See **BREAM**.

**BRESSE**, a territory of Burgundy, in France; it is

bounded by Franche Compte on the north, by Savoy on the east, by Dauphine on the south, and by the Lyonois on the west.

**BRESSICI**, in geography. See **BRESTE**.

**BRESSVIRE**, a town of Poitou, in the Orlesnois, in France, situated about thirty-five miles north-west of Poitiers; W. long.  $30'$ , and N. lat.  $46^{\circ} 50'$ .

**BREST**, in geography, an excellent port-town of Brittany in France; W. long.  $4^{\circ} 30'$ , and N. lat.  $48^{\circ} 25'$ .

**BREST**, or **BREAST**, in architecture, a term sometimes used for the member of a column, more usually called *torus*. See **TORUS**.

**BREST-summers**, in timber buildings, are pieces in the outward thereof, into which the girders are framed: this, in the ground-floor, is called a cell; and, in the garret-floor, a beam.

As to their size, it is the same with that of girders.

See **GIRDERS**.

**BRESTE**, or **BRESSICI**, the capital of the palatinate of Breslavia, and of Polesia, in Poland, situated on the river Bog, about eighty miles east of Warsaw; E. long.  $24^{\circ}$ , and N. lat.  $52^{\circ}$ .

**BRETESSE**, in heraldry, denotes a line embattled on both sides.

**BRETON**, or **CAPE-BRETON**, an American island, subject to the English, and separated from New-Scotland by a narrow strait called Canso: it is about one hundred miles in length, and fifty in breadth, and is situated between  $61^{\circ}$  and  $62^{\circ}$  W. long. and between  $45^{\circ}$  and  $48^{\circ}$  N. lat.

**BRETVEIL**, a town of Normandy, in France, about thirty-five miles south of Rouen; E. long.  $1^{\circ}$ , and lat.  $48^{\circ} 50'$ .

**BRETVEIL** is also the name of a town in Picardy, about six leagues from Amiens.

**BREUBERG**, a country and town of Germany, in the circle of Franconia, situated upon the banks of the Maine.

**BREVE**, in law, is any writ directed to the chancellor, judges, sheriffs, or other officers, whereby a person is summoned, or attached, to answer in the king's court, &c.

**BREVE perquirere**, the purchasing of a writ or licence for trial in the king's courts; whence comes the present usage of paying 6s. 8d. fine to the king in suit, for money due on bond, where the debt is 40l. and of 10s. where it is 100l. &c.

**BREVE de recto** is a writ of right, or licence, for a person ejected, to sue for the possession of the estate detained from him.

**BREVE**, in music, a note or character of time, in the form of a diamond or square, without any tail, and equivalent to two measures or minims.

**BREVET**, in the French customs, denotes the grant of some favour or donation from the king, in which sense it partly answers to our warrant, and partly to letters-patent.

**BREVIARY**, a daily office, or book of divine service, in the Romish church. It is composed of matins, lauds, first, third, sixth, and ninth vespers, and the compline, or post-communio.

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The breviary of Rome is general, and may be used in all places; but on the model of this various others have been built, appropriated to each diocese, and each order of religious.

The breviary of the Greeks is the same in almost all churches and monasteries that follow the Greek rites: the Greeks divide the psalter into twenty parts. In general, the Greek breviary consists of two parts; the one containing the office for the evening, the other that of the morning, divided into matins, lauds, first, third, sixth, and ninth vespers, and the compline; that is, of seven different hours, on account of that saying of David, *Septies in die laudem dixi tibi*.

The institution of the breviary is not very ancient: there have been inserted in it the lives of the saints, full of ridiculous and ill-attested stories, which gave occasion to several reformations of it, by several councils, particularly those of Trent and Cologne; by several popes, particularly Pius V. Clement VIII. and Urban VIII.; and also by several cardinals and bishops, each lopping off some extravagances, and bringing it nearer to the simplicity of the primitive offices. Originally, every body was obliged to recite the breviary every day; but by degrees the obligation was reduced to the clergy only, who are enjoined, under penalty of mortal sin and ecclesiastical censures, to recite it at home, when they cannot attend in public. In the XIVth century, there was a particular reserve granted in favour of bishops, who were allowed, on extraordinary occasions, to pass three days without rehearsing the breviary.

This office was originally called *curfus*, and afterwards the *breviarium*; which latter name imports,

that the old office was abridged, or rather, that this collection is a kind of abridgment of all the prayers.

The breviaries now in use are innumerable; the difference between them consists principally in the number and order of the psalms, hymns, pater-nosters, ave-Maries, creeds, magnificats, cantemus's, benedictus's, canticamus's, nunc dimittis's, miserere's, hallelujah's, gloria patri's, &c.

**BREVIARY**, in Roman antiquity, a book first introduced by Augustus, containing an account of the application of the public money.

**BREVIATOR**, an officer under the eastern empire, whose business it was to write and translate briefs.

At Rome those are still called breviators, or abbreviators, who dictate and draw up the pope's briefs.

**BREVIBUS a rotulis liberandis**, a writ or command to a sheriff to deliver to his successor the county, with the appurtenances, and the rolls, writs, and other things to his office belonging.

**BREVIER**, among printers, a small kind of type or letter between bourgeois and minion.

**BREVIUM custos**. See **CUSTOS**.

**BREVORDT**, a town of Guelderland, in the United Netherlands, situated about twenty-five miles south-east of Zutphen, in 6° 35' E. long. and 52° N. lat.

**BREWER**, a person who professes the art of brewing.

There are companies of brewers in most capital cities; that of London was incorporated in 1427, by Hen. VI. and that of Paris is still older.

**BREWER'S-HAVEN**, a good harbour at the north end of the island of Chiloe, on the coast of Chili, in South America; W. long. 82°, and S. lat. 42°.

**BREW-HOUSE**, a place for brewing. See **BREWING**.

## B R E W I N G.

**BREWING** is the operation of preparing ale or beer from malt. Before we treat of this operation, it will be necessary to explain the nature of malt, and the method of making it.

### O F M A L T.

THAT species of fermentation which is called the *vinous fermentation*, is only producible by the juices of vegetable substances. The sugar or saccharine matter is the cause of this fermentation. If sugar be added to water in the proportion of 1 to 3, a proper vinous fermentation is excited. When this saccharine matter is extracted from vegetables, they immediately lose their fermentative power. Most plants either naturally contain this saccharine matter, or are capable of acquiring it by a certain method of treatment. This process of converting vegetable substances into a sugar is known by the name of *malting*.

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Though most vegetable substances be convertible into malt, barley is found by experience to be the most proper for undergoing this operation.

As the converting of grains into malt, is only a part of the progress towards their germination, it may be performed by committing them for some time to the earth. But the ordinary method is to steep the barley for some time in water, and then to expose it in heaps on the floor of a barn till it begins to heat: after which, it must be spread out in thin layers, to prevent putrefaction. It ought to continue in this situation till the plume or bud is just about to escape from the seed, and then it is considered as perfectly malted; that is, the seeds are converted into a sweet, moist substance. This change of taste, or malting, keeps exact pace with the progress of the plume; hence one half of the seed is frequently malted, while the other undergoes no change. If the plume be allowed to shoot fully out, the seeds immediately lose their saccharine taste, and are changed into insipid

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hollow bags. When seeds are thus sufficiently malted, they must be dried in malt-kilns, the fuel of which should smoke as little as possible.—The husks must now be broke open by malt-milns, and then infused or mashed in warm water, in order to extract the saccharine substance; the heat applied should be very slow and gradual. Thus the malt is dissolved, and lies till the liquor be sufficiently tinctured. When the malt is too long diffused, so that an acetous fermentation begins to take place, it is called *blinking*, or *foxing*, by brewers.

This tincture obtained from the infusion of grinded malt, is commonly known by the name of *wort*.

We shall now give an account of this process in the language and manner of the actual brewer, which will probably be more acceptable than treating it in a philosophical manner.

### *Of making MALT.*

THE barley must be put into a leaden or tiled cistern, that holds five, ten, or more quarters, and covered with water four or six inches above the barley, to allow for its swell. Here it must lie five or six tides, as the maltster calls it, reckoning twelve hours to the tide, according as the barley is in body or in driness. The way to know when it is enough, is to take a corn; end-ways, between the fingers, and gently crush it; and if it be in all parts mellow, and the husk opens, or starts a little from the body of the corn, then it is enough. The nicety of this is a material point; for if it be infused too much, the sweetness of the malt will be greatly taken off, and yield the less spirit, and will cause deadness and sourness in ale or beer in a short time, for the goodness of the malt contributes much to the preservation of all ales and beers. Then the water must be well drained from it, and it will come equal and better on the floor, which may be done in twelve or sixteen hours in temperate weather, but in cold near thirty. From the cistern, it is put into a square hutch or couch, where it must lie thirty hours; then it must be worked night and day in one or two heaps, as the weather is cold or hot, and turned every four, six, or eight hours, the outward part inwards, and the bottom upwards, always keeping a clear floor, that the corn that lies next to it be not chilled; and as soon as it begins to come or spire, then turn it every three, four, or five hours, as was done before, according to the temper of the air, which greatly governs this management; and as it comes or works more, so must the heap be spreaded and thinned larger to cool it. Thus it may lie and be worked on the floor in several parallels, two or three feet thick, ten or more feet broad, and fourteen or more in length, to chip or spire, but not too much nor too fast; and when it is come enough, it is to be turned twelve or sixteen times in twenty-four hours, if the season is warm, as in March, April, or May; and when it is fixed, and the root begins to be dead, then it must be thickened again, and carefully kept often turned and worked, that the growing of the root may not revive, and this is better done with the shoes off than on: And here the workman's art and diligence in particular is tried, in keeping the floor clear,

and turning the malt often, that it neither moulds nor acre-spines, that is, that the blade does not grow out at the opposite end of the root; for, if it does, the flower and strength of the malt is gone, and nothing left behind but the acre-spire, husk, and tail: Now, when it is at this degree, and fit for the kiln, it is often put into a heap, and let lie twelve hours before it is turned, to heat and mellow, which will much improve the malt if it is done with moderation, and after that time it must be turned every six hours during twenty-four; but if it is overheated, it will become like grease and be spoiled, or at least cause the drink to be unwholesome. When this operation is over, it then must be put on the kiln, to dry four, six, or twelve hours, according to the nature of the malt; for the pale sort requires more leisure, and less fire, than the amber or brown sorts: Three inches thick was formerly thought a sufficient depth for the malt to lie on the hair-cloth; but now six is often allowed it; fourteen or sixteen feet square will dry about two quarters, if the malt lies four inches thick, and here it should be turned every two, three, or four hours, keeping the hair-cloth clear: The time of preparing it from the cistern to the kiln is uncertain, according to the season of the year; in moderate weather, three weeks are often sufficient. When the malt is dried, it must not cool on the kiln, but be directly thrown off, not into a heap, but spreaded wide in an airy place, till it is thoroughly cool; then put it into a heap, or otherwise dispose of it.

There are several methods used in drying of malts, as the iron-plate frame, the tile-frame, that are both full of little holes; the brass-wired, and iron-wired frame, and the hair-cloth. The iron and tiled ones were chiefly invented for drying of brown malts, and saving of fuel; for these, when they come to be thorough hot, will make the corns crack and jump by the fierceness of their heat, so that they will be roasted or scorched in a little time; and after they are off the kiln, to plump the body of the corn, and make it take the eye, some will sprinkle water over it, that it may meet with the better market: But if such malt is not used quickly, it will slacken and lose its spirits to a great degree, and perhaps, in half a year or less, may be taken by the whools and spoiled. Such hasty dryings, or scorplings, are also apt to bitter the malt, by burning its skin, and therefore these kilns are not so much used now as formerly. The wire-frames indeed are something better, yet they are apt to scorch the outward part of the corn, that cannot be got off so soon as the hair-cloth admits of, for these must be swept when the other is only turned at once; however, these last three ways are now in much request for drying pale and amber malts, because their fire may be kept with more leisure, and the malt more gradually and better dried. But by many the hair-cloth is reckoned the best.

Malts are dried with several sorts of fuel; as the coak, Welch coal, straw, wood, and fern, &c. But the coak is reckoned by most to exceed all others for making drink of the finest flavour and pale colour, because it sends no smoke forth to hurt the malt with any offensive tang, that wood, fern, and straw are apt to do



in a lesser or greater degree; but there is a difference even in what is called coak, the right sort being large pit-coal charred or burnt in some measure to a cinder, till all the sulphur is consumed and evaporated, which is called choak; and this, when it is truly made, is the best of all other fuels. But if there be but one cinder as big as an egg, not thoroughly cured, the smoke of this one is capable of doing damage, which happens too often by the negligence or avarice of the choak-maker: There is another sort, by some wrongly called choak, and rightly named culm or Welch-coal, from Swanzey in Pembrokehire, being of a hard stony substance, in small bits, resembling a shinning coal, and will burn without smoke, and by its sulphureous effluvia cast a most excellent whiteness on all the outward parts of the grainy body: In Devonshire their marble or grey fire-stone is burnt into lime with the strong fire that this culm makes, and both this and the chalked pit-coal afford a moderate and certain fire to all malt that is dried by it. Straw is the next sweetest fuel; but wood and fern are the worst.

Some put a peck or more of pease, and malt them with five quarters of barley, to mellow the drink: Beans are used for the same purpose; but they do not come so soon, nor mix so conveniently with the malt, as the pea.

Barley is not fit to make malt of till it is fully mellowed and sweated in the mow, and the season of the year is ready for it, without both which there can be no assurance of good malt. This untimely making of malt often occasions bad ales and beers; for such malt retaining some of its barley nature, or that the season of the year is not cold enough to admit of its natural working on the floor, is not capable of producing a true malt, but will cause its drink to stink in the cask instead of growing fit for use, as not having its genuine malt nature to cure and preserve it, which all good malts contribute to as well as the hop.

Mellilet, a most stinking weed that grows among barley, if not thoroughly cleaned from it before malting, makes the drink too heady, that it is apt to intoxicate the unwary by drinking a small quantity: Besides, it gives a nauseous flavour to the liquor.

#### *To know good from bad Malts.*

FIRST, break the malt-corn across between the teeth, in the middle, or at both ends, and if it tasteth mellow and sweet, has a round body, breaks soft, is full of flour all its length, smells well, and has a thin skin, then it is good. Secondly, take a glass near full of water, and put in some malt; if it swims, it is right; but if any sinks to the bottom, then it is not true malt, but steely, and retains somewhat of its barley nature; this, however, is not an infallible rule, because, if a corn of malt is cracked, split, or broke, it will then take the water and sink; but an allowance may be given for such incidents, and still room enough to make a judgment. Thirdly, malt that is truly made will not be hard and steely, but of so mellow a nature, that, if forced against a dry board, it will mark, and cast a white colour almost like chalk. Fourthly, malt that is not rightly made will be

part of it of a hard barley nature, and weigh heavier than that which is true malt.

#### *Of the Nature and Use of Pale, Amber, and Brown Malts.*

THE pale malt is the slowest and slackest dried of any, and where it has had a leisure fire, a sufficient time allowed it on the kiln, and a due care taken of it, the flour of the grain will remain in its full quantity, and thereby produce a greater length of wort than the brown high-dried malt. It may be brewed either with spring or common well water.

The amber-coloured malt is that which is dried in a medium degree, between the pale and the brown, and is very much in use, as being free of either extreme. Its colour is pleasant, its taste agreeable, and its nature wholesome, which makes it be preferred by many as the best of malts; this by some is brewed either with hard or soft waters, or a mixture of both.

The brown malt is the soonest and highest dried of any, even till it is so hard, that it is difficult to bite some of its corns asunder. This malt, by some, is thought to occasion the gravel or stone, and is by its steely nature less nourishing than the pale or amber malts, being very much impregnated with the fiery particles of the kiln, and therefore its drink sooner becomes sharp and acid than that made from the pale or amber sorts, if they are all fairly brewed: For this reason the London brewers mostly use the Thames or New River waters to brew this malt with, for the sake of its soft nature, whereby it agrees with the harsh qualities of it better than any of the well or other hard sorts, and makes a luscious ale for a little while, and a but-beer, or porter, that will keep very well five or six months; but after that time it generally grows stale, notwithstanding there be ten or twelve bushels allowed to the hoghead, and it be hopped accordingly.

Pale and amber malts dried with coak or culm, obtain a more clean, bright, pale colour, than if dried with any other fuel, because there is not smoak to darken and sully their skins or hulks, and give them an ill relish, which those malts have, more or less, that are dried with straw, wood, or fern, &c. The coak or Welch coal also makes more true and compleat malt than any other fuel, because its fire gives both a gentle and certain heat, whereby the corns are in all their parts gradually dried; and therefore of late these malts have gained such a reputation, that great quantities have been consumed in most parts of the nation for their wholesome nature and sweet fine taste.

Next to the coak-dried malt, the straw-dried is the sweetest and best tasted: This, it must be acknowledged, is sometimes well malted, where the barley, wheat, straw, conveniencies, and the maker's skill, are good; but as the fire of the straw is not so regular as the coak, the malt is attended with more uncertainty in its making, because it is difficult to keep it to a moderate and equal heat, and also exposes the malt in some degree to the taste of the smoak.

Brown malts are dried with straw, wood, and fern, &c.

*Ec.* the straw-dried is the best; the wood-sort has a most ungrateful taste, and few can bear it, but the necessitous, and those that are accustomed to its strong smoaky tang; yet it is much used in some of the western parts of England.

The fern-dried malt is also attended with a rank disagreeable taste from the smook of this vegetable.

#### *Of grinding Malts.*

THIS article well deserves the notice of all brewers, for on it the goodness of our drink greatly depends; because, if it is ground too small, the flour of the malt will be the easier and more freely mixed with the water, and will cause the wort to run thick; therefore the malt must be only just broke in the mill, to make it emit its spirit gradually, and incorporate its flour with the water in such a manner, that first a stout beer, then an ale, and afterwards a small beer may be had at one and the same brewing, and the wort run off fine and clear to the last. Many are likewise so sagacious as to grind their brown malt a fortnight before they use it, and keep it in a dry place, that it may become mellow, by losing in a great measure the fury of its harsh fiery particles, and its steely nature, which this sort of malt acquires on the kiln. However, this, as well as many other hard bodies, may be reduced by time and air into a more soluble, mellow, and soft condition, and then it will imbibe the water, and give a natural kind tincture more freely, by which a greater quantity and stronger drink may be made than if it was used directly from the mill, and be much smoother and better tasted. But pale malts will be fit for use at a week's end, because the leisureness of their drying endows them with a softness from the time they are taken off the kiln to the time they are brewed, and supplies in them what time and air must do in the brown sorts. This method of grinding malt so long beforehand cannot be so conveniently practised by some of the great brewers, because several of them brew two or three times a week; but now most of them grind their malts into the tun by the help of a long, descending, wooden spout; and here they save the charge of emptying or uncasing it out of the bin, and also the waste of a great deal of the malt-flour, that is lost when carried in baskets. A steel hand-mill, will, by the help of only one man, grind six or eight bushels in an hour, and will last a family many years without hardening or cutting. There are some old-fashioned stone hand-mills in being, that some prefer to the iron ones, because they alledge that these break the corn's body, when the iron ones only cut it in two, which occasions the malt, so broke by the stones, to give the water a more easy, free, and regular power to extract its virtue, than the cut-malt can that is more confined within its hull. Notwithstanding, the iron ones are now mostly in use, for their great dispatch and long duration. In the country they frequently throw a sack of malt on a stone or brick floor as soon as it is ground, and let it lie, giving it one turn, for a day or two, that the stones or bricks may draw out the fiery quality it received from the kiln, and give the drink a soft mild taste.

#### *Of the Nature of several Waters, and their Use in Brewing.*

WATER is a matter of great importance in brewing wholesome fine malt-liquors, Now, the more simple and freer every water is from foreign particles, it is the better.

Spring-waters are in general liable to partake of those minerals through which they pass. At Uppingham in Rutland, their water is said to come off an alum-rock, and so tinges their beer with its saline quality, that it is easily tasted at the first draught. But that which will lather with soap, or soft water, that percolates through chalk, or a grey fire-stone, is generally accounted best; for chalk in this respect excells all other earths, because it communicates nothing unwholesome to the waters, but absorbs any minerals that may accompany the water that runs through them: For which reason they throw in great quantities of chalk into their wells at Ailesbury to soften their water, which, coming off a black sand-stone, is so hard and sharp, that it will often turn their beer sour in a week's time; so that in its original state it is neither fit to wash nor brew with, but so long as the alkaline particles of the chalk hold good, they put it to both uses.

River-water is less liable to be loaded with metallic, petrifying, or saline particles, than the well or spring sorts, especially at some distance from the spring head, because the rain-water mixes with and softens it. But in running, it often collects gross particles, from ozymuddy mixtures, particularly near town, which make the beer subject to new fermentations, and grow foul upon any alteration of the weather, as the Thames-water generally does; yet this, for its softness, is much better than the hard sort; however, both these waters are used by some brewers. But where river-water can be had clear in a dry time, when no great rain has lately fell out of rivulets, or rivers that have a gravelly, chalky, sandy, or stony bottom, free from the disturbance of cattle, &c. and in good air, it may then justly claim the name of a most excellent water for brewing, and will make a stronger drink with the same quantity of malt than any of the well-waters; inasmuch that that of the Thames has been proved to make as strong beer with seven bushels of malt, as well-water with eight; and so are all river-waters in a proportionable degree, and, where they can be obtained clean and pure, drink may be drawn fine in a few days after tunning.

Rain-water is very soft, of a most simple and pure nature, and the best diluter of any, especially if received free from dirt and mortar that often mix with it as it runs off tiled roofs; this is very agreeable for brewing of ales that are not to be kept long, but for beers that are to remain some time in the casks, it is not so good, being apt to putrify the soonest of any.

Pond waters. This includes all standing waters, chiefly from rain, and are good or bad according to circumstances; for where there is a clean bottom, and the water lies undisturbed from the tread of cattle, or too many fish, in an open sound air, in a large quantity, and where

where the sun has free access, it is then nearly as good as rain or river-waters. But where it is in a small quantity, or full of fish (especially the sling-tench) or is so disturbed by cattle, as to force up mud and filth, it is then the most foul and disagreeable of all others: So is it likewise in long dry seasons, when our pond-waters are so low as to oblige us to strain it through sieves before we can use it, to take out the small red worms and other corruptions that stagnant waters are subject to.

### *The London Method of Brewing.*

#### *Stout Butt-beer or Porter.*

THIS is the strongest porter that is brewed from brown malt, and often sold for forty shillings the barrel, or six pounds the butt out of the wholesale cellars: The liquor (for it is six-pence forfeit in the London brew-house if the word *water* is named) in the copper designed for the first mash, has a two-bushel basket, or more, of the most hully malt thrown over it, to cover its top, and afterwards its boiling; this must be made very hot, almost ready to boil, yet not so as to blister, for then it will be in too high heat; but, as an indication of this, the foul part of the liquor will ascend, and the malt swell up, and then it must be parted, looked into, and felt with the finger or back of the hand, and if the liquor be clear, and of such heat as can be but just endured, it is then enough, and the stoker must damp his fire as soon as possible, by throwing in a good parcel of fresh coals, and shutting his iron vent-doors; immediately on this, they let as much cold liquor or water run into the copper as will make it all of a heat, somewhat more than blood-warm; this they pump over, or let it pass by a cock into an upright wooden square spout or trunk, and it directly rises through the holes of a false bottom into the malt, which is worked by several men with oars for about half an hour, and is called the first and stiff mash: While this is doing, there is more liquor heating in the copper, that must not be let into the mash-tun till it is very sharp, almost ready to boil; with this they mash again, then cover it with several baskets of malt, and let it stand an hour before it runs into the under-back, which, when boiled an hour and a half with a good quantity of hops, makes this stout. The next is mashed with a cooler liquor, then a sharper, and the next blood-warm or quite cold; by which alternate degrees of heat, a quantity of small beer is made after the stout.

#### *To make Porter, or Butt-beer, to have a fine Tang.*

THIS, of late, has been improved two ways: First, by mixing two bushels of pale malt with six of brown, which will preserve butt-beer in a mellow condition, and cause it to have a pleasant sweet flavour: And, secondly, further to improve and render it more palatable, they boil it two hours and a half, and work it two days as cold as possible in the tun; at last, they stir it, and put a good handful of common salt into the quantity of a butt: Then, when the yeast has had one rising more, they tun it.

#### *Strong Brown Ale, called Stitch.*

MOST of this is the first running of the malt, but yet

of a longer length than is drawn from the stout; it has but few hops boiled in it, and is sold for eight-pence per gallon at the brew-house out of the tun, and is generally made to amend the common brown ale with, on particular occasions.

#### *Common Brown Ale and Starting-beer.*

THEY take the liquors from the brown ale as for the stout, but draw a greater quantity from the malt than for stout or stitch; and after the stiff and second mash, they cap the goods with fresh malt, to keep in the spirit, and boil it an hour; after this, small beer is made of the same goods. Thus also the common brown starting butt-beer or porter is brewed, only boiled with more hops an hour and a half, and worked cooler and longer than the brown ale, and a shorter length drawn from the malt. But it is customary after the brown ale, or when a quantity of small beer is wanted, or is to be brewed better than ordinary, to put so much fresh malt on the goods as will answer that purpose.

#### *Pale and Amber Ales and Beer.*

As the brown malts are brewed with river, these are brewed with well or spring-liquors. The liquors are by some taken sharper for pale than brown malts, and, after the first scalding liquor is put over, some lower the rest by degrees, to the last, which is quite cold, for their small beer; and for butt-beers, there is no other difference than the addition of more hops, and boiling, and the method of working.

#### *Entire Guile Small Beer.*

ON the first liquor they throw some hully malt, to shew the break of it, and when it is very sharp, they let in some cold liquor, and run it into the tun milk-warm; this is mashed with thirty or forty pulls of the oar, and let stand till the second liquor is ready, which must be almost scalding hot to the back of the hand; then run it by the cock into the tun, mash it up, and let it stand an hour before it is spent off into the under-back: These two pieces of liquor will make one copper of the first wort, without putting any fresh malt on the goods; the next liquor to be blood-warm, the next sharp, and the next cool or cold; for the general way in great brew-houses is, to let a cool liquor precede a sharp one, because it gradually opens the pores of the malt and goods, and prepares the way for the hotter liquor that is to follow.

*The several Lengths or Quantities of Drinks that have been made from Malt, and their several Prices, as they have been sold at a common Brew-house.*

FOR stout-beer, is commonly drawn one barrel off a quarter of malt, and sold for thirty shillings per barrel from the tun. For stitch or strong brown ale, one barrel and a firkin, at one and twenty shillings and four pence per barrel from the tun. For common brown ale, one barrel and a half, or more, at sixteen shillings per barrel, that holds thirty-two English gallons from the tun. For entire small beer, five or six barrels off a quarter, at seven or eight shillings per barrel from the tun. For pale and amber ale, one barrel and a firkin, at one shilling per gallon, from the tun.

*A Method practised by a Victualler, for Brewing Ale or October Beer, from Nottingham.*

His copper holds twenty-four gallons, and the mash-tub has room enough for four or more bushels of malt. The first full copper of boiling water he puts into the mash-tub, there to lie a quarter of an hour, till the steam is so far spent that he can see his face in it; or, as soon as the hot water is put in, throws a pail or two of cold water into it, which will bring it at once into a temper; then he lets three bushels of malt be run leisurely into it, and stirred or mashed all the while, but as little as can be, or no more than just to keep the malt from clotting or balling; when that is done, he puts one bushel of dry malt at the top, to keep in the vapour or spirit, and so lets it stand covered two hours, or till the next copper-full of water is boiling hot, which he lades over the malt or goods three hand-bowls full at a time, that are to run off at the cock or tap by a very small stream before more is put on, which again must be returned into the mash-tub till it comes off exceeding fine; for, unless the wort is clear when it goes into the copper, there are little hopes it will be so in the barrel; which leisure way obliges him to be sixteen hours in brewing these four bushels of malt. Now between the ladings-over he puts cold water into the copper to be boiling hot, while the other is running off; by this means his copper is kept up near full, and the cock spending to the end of brewing his ale or small beer, of which only twenty-one gallons must be saved of the first wort that is reserved in a tub, wherein four ounces of hops are put, and then it is to be set by. For the second wort we will suppose there are twenty gallons of water in the copper boiling hot, that must be all laded over in the same manner as the former was, but no cold water need here be mixed; when half of this is run out into a tub, it must be directly put into the copper with half of the first wort, strained through the brewing-sieve as it lies on a small wooden loose-frame over the copper, to keep back those hops that were first put in to preserve it, which is to make the first copper twenty-one gallons; then, upon its beginning to boil, he puts in a pound of hops in one or two canvas or other coarse linen bags, somewhat larger than will just contain the hops, that an allowance may be given for their swell; this he boils away very briskly for half an hour, when he takes the hops out and continues boiling the wort by itself till it breaks into particles a little ragged, and then it is enough, and must be dispersed into the cooling-tubs very thin: Then put the remainder of the first and second wort together, and boil that the same time, in the same manner, and with the same quantity of fresh hops, as the first was. The rest of the third or small-beer wort will be about fifteen or twenty gallons more or less, which he mixes directly with some cold water to keep it free of excise, and puts it into the copper as the first liquor to begin a second brewing of ale, with another four bushels of malt as he did before, and so on for several days together if necessary; and at last there may be some small-beer made.

#### *The Nature and Use of the Hop.*

**THIS** vegetable was formerly thought to be an un-

wholesome ingredient. Indeed, when the hop, in a dear time, is adulterated with water, in which aloes, &c. have been infused, in order to make the old hops recover their bitterness, and seem new, then they are to be looked on as unwholesome; but the pure new hop, when properly managed, has no hurtful qualities. But if the hops are boiled in strong or small worts beyond their fine and pure nature, the liquor suffers, and will be tanged with a noxious taste, both ungrateful and unwholesome to the stomach; and, if boiled to a very great excess, they will be apt to cause reachings. It is for these reasons that we advise the boiling two parcels of fresh hops in each copper of ale-wort; and, if there were three for keeping beer, it would be so much the better for the taste, health of body, and longer preservation of the beer in a sound smooth condition. For this purpose; some make a bag, like a pillowber, and boil the hops in it half an hour; then take them out, and put in another bag of the like quantity of fresh hops, and boil them half an hour more; by which means there is an opportunity of boiling both wort and hops a due time, saving the trouble of straining them through a sieve, and securing the seeds of the hops at the same time from mixing with the drink; afterwards they boil the same bags in the small beer, till the substance of it is got out; but observe that the bags be made larger than what would just contain the hops, otherwise it will be difficult to boil out their substance. It is true, that here is a charge increased by the consumption of a greater quantity of hops than usual; but then how greatly will they answer the desired end of enjoying fine-palated wholesome drink, that, in a cheap time, will not amount to much, if bought at the best hand; and, if we consider their after-use and benefit in small beer, there is not any loss at all in their quantity: But, where it can be afforded, the very small beer would be much improved if fresh hops were also shifted in the boiling of this as well as the stronger worts. Hence may appear the hardships that many are under of being necessitated to drink of those brewers malt-liquors, who, out of avarice, boil their hops to the last, that they may not lose any of their quintessence.

After the wort is cooled and put into the working-vat or tub, some throw fresh hops into it, and work them with the yeast, at the same time reserving a few gallons of raw wort to wash the yeast through a sieve to keep back the hop. This is a good way where enough of hops have not been sufficiently boiled in the wort, or to preserve it in the coolers where it is laid thick.

When hops are dear, many use the seeds of worm-wood instead of them: Others use the daucus or wild-carrot seed that grows in our common fields, which many of the poor people gather and dry in their houses, for the purpose of selling them to the brewers: Others use horehound, which indeed is a fine bitter, and grows on several of our commons.

Hops have a fine grateful bitter, which makes the drink easy of digestion; they also keep it from running, into such cohesions as would make it ropy, rapid, and sour; and therefore are not only of great use in boiled, but in raw worts, to preserve them sound till they can be

put.

put into the copper, and afterwards in the tun, while the drink is working.

Here then it must be observed, that the earthy part of the hop is the cause of that rough, harsh, unpleasant taste which accompany both ales and beers that have the hops so long boiled in them, as to tincture their worts with their mischievous effects; for, notwithstanding the malt be ever so good, the hops, if boiled too long in them, will be so predominant as to cause a bad taste.

### *Of boiling Malt-liquors.*

ALTHOUGH it has been formerly said, that an hour and a half is requisite for boiling of October beer, and an hour for ales and small beer; yet it is to be observed, that an exact time is not altogether a certain rule in this case; for, when loose hops are boiled in the wort so long till they all sink, their seeds will arise and fall down again; the wort also will be curdled, and broken into small particles if examined in a hand-bowl, but afterwards into larger, as big as great pins heads, and will appear clean and fine at the top. This is so much a rule with some, that they regard not time, but this sign, to shew when the wort is boiled enough; and this will happen sooner or later, according to the nature of the barley, and its being well malted; for, if it comes off chalks or gravels, it generally has the good property of breaking or curdling soon; but, if off tough clays, then it is longer, which, by some persons, is not a little valued, because it saves time in boiling, and consequently the consumption of the wort.

It is also to be observed, that pale malt-worts will not break so soon in the copper as the brown sorts; but, when either of their worts boil, it should be to the purpose, for then they will break sooner, and waste less, than if they are kept simmering, and will likewise work more kindly in the tun, drink smoother, and keep longer.

Now all malt-worts may be spoiled by too little or too much boiling: If too little, then the drink will always taste raw, mawkish, and be unwholesome in the stomach, where, instead of helping to dilute and digest our food, it will cause obstructions, cholics, head-achs, and other diseases: Besides, all such under-boiled drinks are certainly exposed to staleness and sourness, much sooner than those that have had their full time in the copper. And if they are boiled too long, they will then thicken and not come out of the copper fine and in a right condition which will cause it never to be right clear in the barrel.

But to be more particular, no ale-worts, boiled less than an hour, can be good; because, in an hour's time, they cannot acquire a thickness of body any ways detrimental to them; and, in less than an hour, the ramous viscid parts of the ale cannot be sufficiently broke and divided, so as to prevent its running into cohesions, ropiness, and sourness; because in ales there are not hops enough allowed to do this, which good boiling must in a great measure supply, or else such drink can never be good; for then its cohesive parts being not thoroughly broke and comminuted by time and boiling, remain hard,

and in a good measure indigestible in the stomach: How ignorant then are those people, who, in tipping of such liquor, can praise it for excellent good ale, only because its taste is sweetish, (which is the nature of such raw drinks), believing it to be the pure effect of the genuine malt, and not perceiving the brewer's avarice and cunning, to save the consumption of his wort by shortness of boiling, tho' to the great prejudice of the drinker's health?

In boiling, both time and the curdling or breaking of the wort should be consulted; for if a person was to boil the wort an hour, and then take it out of the copper before it was rightly broke, it would be wrong management, and the drink would not be fine and wholesome; and if it should boil an hour and a half, or two hours, without regarding when its particles are in a right order, then it may be too thick; so that due care must be had to the two extremes, to obtain it in its due order; therefore, in October and keeping beers, an hour and a quarter's good boiling is commonly sufficient to have a thorough cured drink; for generally in that time it will break and boil enough; because in this there is a double security by length of boiling, and a quantity of hops shifted; but in the new way there is only a single one, and that is by a double or treble allowance of fresh hops boiled only half an hour in the wort; and for this practice a reason is assigned, that the hops, being endowed with discutient aperitive qualities, will, by them and their great quantity, supply the defect of underboiling the wort; and that a farther conveniency is here enjoyed by having only the fine, wholesome, strong, floury, spirituous parts of the hop in the drink, exclusive of the phlegmatic, earthy parts which would be extracted, if the hops were to be boiled above half an hour; and therefore there are many now that are so attached to this new method, that they will not brew ale or beer any other way, thinking, that if hops are boiled above thirty minutes, the wort will exhibit some of their bad qualities.

The allowance of hops for ale or beer cannot be exactly adjusted without coming to particulars, because the proportion should be according to the nature and quality of the malt, the season of the year it is brewed in, and the length of time it is to be kept.

For strong brown ale brewed in any of the winter-months, and boiled an hour, one pound is but barely sufficient for a hoghead, if it be tapped in three weeks or a month.

If for pale ale brewed at that time; and for that age, one pound and a quarter of hops; but if these ales are brewed in any of the summer-months, there should be more hops allowed.

For October or March brown beer, a hoghead made from eleven bushels of malt boiled an hour and a quarter, to be kept nine months, three pounds and a half ought to be boiled in such drink at the least.

For October or March pale beer, made from fourteen bushels, boiled an hour and a quarter, and kept twelve months, six pounds ought to be allowed to a hoghead of such drink, and more if the hops are shifted in two bags, and less time given the wort to boil.

*Of Foxing or Tainting Malt-Liquors.*

FOXING is a misfortune, or rather a disease, in malt-drinks, occasioned by divers means, as the nastiness of the utensils, putting the worts too thick together in the backs or coolers, brewing too often and soon one after another, and sometimes by bad malts and waters, and the liquors taken in wrong heats, being of such pernicious consequence to the great brewer in particular, that he sometimes cannot recover and bring his matters into a right order again in less than a week or two, and is so hateful to him in its very name, that it is a general law among them to make all servants that name the word *Fox* or *Foxing* in the brew-house to pay six-pence, which obliges them to call it *Reynard*; for, when once the drink is tainted, it may be smelt at some distance somewhat like a *Fox*: It chiefly happens in hot weather, and causes the beer and ale so tainted to acquire a fullsome sickish taste, that will, if it is received in a great degree, become ropy like treacle, and in some short time turn sour.

And here we shall mention the great value of the hop in preventing and curing the fox in malt-liquors. When the wort is run into the tub out of the mashing-vat, it is a very good way to throw some hops directly into it before it is put into the copper, and they will secure it against sourness and ropiness, that are the two effects of foxed worts or drinks, and are of such power in this respect, that raw worts may be kept some time, even in hot weather, before they are boiled, and which is necessary where there is a large quantity of malt used to a little copper; but it is certain that the stronger worts will keep longer with hops than the smaller sorts: So likewise, if a person has fewer tubs than are wanted, and he is apprehensive his worts will be foxed by too thick lying in the coolers or working tubs, then it will be a safe way to put some fresh hops into such tubs, and work them with the yeast, or, in case the drink is already foxed in the vat or tun, new hops should be put in and worked with it, and they will greatly fetch it again into a right order; but then such drink should be carefully taken clear off from its gross nasty lee, which being mostly tainted, would otherwise lie in the barrel, corrupt, and make it worse.

Some sift quick-lime into foxed drinks while they are working in the tun or vat, that its fire and salt may break the cohesions of the beer or ale, and burn away the stench that the corruption would always cause; but then such drink should by a peg at the bottom of the vat be drawn off as fine as possible, and the dregs left behind.

*Of fermenting and working of Beers and Ales.*

THOUGH a small quantity of yeast be necessary to ferment and fine the wort; yet it is in itself of a poisonous nature, and if beat into the wort too often or in too large a quantity, by its stupifying and narcotic quality, it makes the liquor so heady, that five bushels of malt may be equal in strength to six. But liquor made in this manner is extremely unwholesome.

It is alledged indeed, that beating the yeast into wort gives it a fine relish, or it makes the ale bite of the yeast; but the true reason is, to further its sale, on account of its intoxicating quality. But some people are so fond of white thick ale, that they often kill themselves by drinking it; nor is their humour much different as to the common brewers brown ale, who, when the customer wants a hoghead, they put in immediately a handful of salt, and another of flour, and so bring it up; this is no sooner on the stilling than it is tapped, that it may carry a froth on the top of the pot, otherwise they despise it. See CHEMISTRY, *Of fermentation.*

*Of working and fermenting London Stout Beer and Ale.*

THE yeast is at once put into the tun to work the stout-beer and ale with; by this means, and the shortness of time we have to ferment our strong drinks, we cannot make reserves of cold worts to mix with and check the too forward working of those liquors. The strong beer brewed for keeping is suffered to be blood-warm in the winter, when the yeast is put into it, that it may gradually work two nights and a day at least, for this will not admit of such a hasty operation as the common brown ale, because, if it is worked too warm and hasty, such beer will not keep near so long as that fermented cooler. The brown ale has, indeed, its yeast put into it in the evening very warm, because it is often carried away the very next morning. The pale or amber ales are often kept near it, not quite a week under fermentation, for the better incorporating the yeast with the wort.

*Of forwarding and retarding the Fermentation of Malt-liquors.*

IN case beer or ale is backward in working, it is customary to cast some flour out of the dusting-box, or with the hand, over the top of the drink, which will become a sort of crust or cover to help to keep the cold out: Others put in one or two ounces of powdered ginger, which heats the wort and brings it forward: Others take a gallon stone-bottle and fill it with boiling water, which, being well corked, is put into the working tub, where it communicates a gradual heat for some time, and forwards the fermentation: Others reserve some raw wort, which they heat and mix with the rest; but then care must be taken, that the pot in which it is heated has no manner of grease about it, lest it should impede, instead of promoting the working; but, for retarding and keeping back any drink that is too much heated in working, the cold raw wort is the most proper of any thing to check it; though some are known to put one or more pewter dishes into it for that purpose; or, it may be broke into several other tubs, where, by its shallow lying, its fury will be abated. Others again, to make drink work that is backward, will take the whites of two eggs, and beat them up with half a quartern of good brandy, and put it either into the working-vat, or into the cask, which will quickly bring it forward, if a warm cloth is put over the bung: Others tie up bran in a coarse thin cloth, and put it into the vat, where, by its spongy nature, it absorbs a quantity of the drink, and breeds a heat to forward its working.

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Some brewers take off all the top yeast first, and then, by a peg near the bottom of the working-tub, draw off the beer or ale, so that the dregs are by this means left behind. This is very right, in ales that are to be drank soon; but in beers, that are to lie nine or twelve months in a butt or other cask, there certainly will be wanted some *feces* or sediments for the beer to feed on, else it must consequently grow hungry, sharp, and eager; and therefore, if its own top or bottom are not put into a cask with the beer, some other artificial composition, or lee, should supply its place, that is wholesomer, and will better feed with such drink, than its own natural settlement; and therefore, there are here inserted several receipts for answering this end.

*Of artificial Lees for Stout or Stale Beer to feed on.*

THIS article is of very great importance in the curing of our malt-liquors. The general misfortune of the porter or keeping-beers drinking hard and harsh, is partly owing to the nasty foul *feces* that lie at the bottom of the cask, compounded of the sediments of malt, hops, and yeast. Wheat is, by many, put into such beer to feed and preserve it, as being reckoned a substantial alkali; however, it has been proved, that such wheat in about three years time has eat into the very wood of the cask. Others hang a bag of wheat in the vessel, that it may not touch the bottom; but, in both cases, the wheat is discovered to absorb and collect the acid qualities of the beer, yeast, and hop. Hence it is, that such whole wheat is loaded with the qualities of the unwholesome settlements or grounds of the beer, and becomes of such a corroding nature, as to do mischief; and, for that reason, some hang a bag of the flour of malted oats, wheat, pease, or beans, in the vessels of beer, as being of a lighter and mellow body than the whole wheat or its flour, and more natural to the liquor: But whether it be raw wheat or malted, it is supposed, after this receptacle has emitted its alcalous properties to the beer, and taken in all it can of the acid qualities thereof, that such beer will in time prey upon that again, and so communicate its pernicious qualities to the liquor.

*Composition for feeding Porter or Keeping-Beers.*

TAKE a quart of French brandy, or as much of English, that is free from any burnt tang, or other ill taste, and is full proof; to this put as much wheat or bean-flour as will knead it into dough, put it in long pieces into the bung-hole, as soon as the beer has done working, or afterwards, and let it gently fall piece by piece to the bottom of the butt; this will maintain the drink in a mellow freshness, keep staleness off for some time, and cause it to be the stronger as it grows aged.

*Another.*

TAKE one pound of treacle, or honey, one pound of the powder of dried oyster-shells, or fat chalk, mix them well, and put it into a butt, as soon as it has done working, or some time after, and bung it well; this will both fine and preserve the beer in a soft, smooth condition for a great while.

*Another.*

TAKE a peck of egg-shells, and dry them in an oven, break and mix them with two pounds of fat chalk, and mix them with water wherein four pounds of coarse sugar have been boiled, and put it into the butt as aforesaid.

*To fine and preserve Beers and Ales, by boiling an Ingredient in the Wort.*

IN each barrel-copper of wort, put in two quarts of whole wheat as soon as possible, that it may soak before it boils; then strain it through a sieve, and put the wort in cooling-tubs: Thus there will be extracted a gluey consistence, which, being incorporated with the wort by boiling, gives it a more thick and ponderous body, and, when in the cask, soon makes a sediment or lee, as the wort is more or less loaded with the weighty particles of this sily body; but if the wheat were first parched, or baked in an oven, it would do better, as being rather too raw as it comes from the ear.

*To stop the Fret in Malt-liquors.*

TAKE a quart of black cherry-brandy, and pour it in at the bung-hole of the hoghead, and stop it close.

*To recover deadish Beer.*

WHEN strong drink grows flat, by the loss of its spirits, take four or five gallons out of a hoghead, and boil it with five pounds of honey, skim it, and, when cold, put it to the rest, and stop it up close: This will make it pleasant, quick, and strong.

*To make Stale Beer drink new.*

TAKE the herb horehound, stamp it and strain it, then put a spoonful of the juice (which is an extreme good pectoral) to a pitcher full of beer, let it stand covered about two hours, and drink it.

*To fine Malt-liquors.*

TAKE a pint of water, half an ounce of unslacked lime, mix them well together; let it stand three hours, and the lime will settle to the bottom, and the water be as clear as glass; pour the water from the sediment, and put it into your ale or beer; mix it with half an ounce of ising-glass, first cut small and boiled; and in five hours time, or less, the beer in the barrel will settle and be clear.

*Receipt for making Balls for fining, feeding, preserving, relishing, and colouring Malt Drinks, Wines, and Cyders.*

*Brown Balls.*

ALABASTER, or marble calcined into a powder, two pounds. Oyster-shells, a little calcined and freed from their brown or dirt-coloured outside, one pound. Pure fat chalk, well dried, one pound. Horse-bean flour, first freed from the hulls, one pound. Red Saunders, four ounces. Grains of paradise, half an ounce. Florentine orrice-root, half an ounce. Coriander-seed, a quarter of an ounce. Cloves, in number six. Hops, half an ounce. The best staple incised ising-glass, two ounces. The first runnings of the molasses, or treacle, two pounds.

*Pale Balls,*

ARE made in the same manner, and with the like quantity of every thing, except a pound or two of fine sugar made into a syrup, instead of the molasses, and omitting the saunders.

*N. B.* The powders are to be pretty fine, and the balls dried very gradually without heat for the first three or four days upon brown paper laid over a large sieve bottom, and turned often. Afterwards they may be put into the sun, or at a proper distance from the fire, in order to dry them thoroughly; and the quantity of the hops may be augmented, or wholly omitted, at discretion, according as the liquor requires.

Put as much water to your glass as will just cover it, in order to open its body, letting it stand so twelve hours; then add the following infusion to it, and gradually dissolve the whole over a gentle fire. Then strain it off hot among some of the powder, adding the rest by a little at a time, with some of the treacle or syrup likewise alternately, till you beat the whole into a stiff mass, out of which form balls weighing four ounces each.

*The infusion.*—Pour a pint of boiling water upon the coriander-seed, and cloves bruised, and the hops well rubbed. Cover them close, and let it stand twelve hours, then strain for the use aforesaid.

*The number of balls for each cask.*—Powder one of the balls and put it into a pin or half a firkin; into a firkin, two; into a kilderkin, three; into a barrel, six; and so on in proportion as the cask is larger or lesser, stirring them well in; and, if the liquor has age enough, so that it will bear racking, it should be first served so, and then they will answer much better.

*Of the Cellar or Repository for keeping Beers and Ales.*

It is certain, that the weather has not only a power or influence in brewing, but also after the drink is in the barrel, hoghead, or butt, in cellars, or other places, which is often the cause of forwarding or retarding the fineness of malt-liquors; for if we brew in cold weather, and the drink is to stand in a cellar of clay, or where springs rise, or waters lie or pass through such a place, these will check the due course of the drink, chill, flat, deaden, and hinder it from becoming fine. So likewise, if beer or ale is brewed in hot weather, and put into chalky, gravelly, or sandy cellars, and especially if the windows open to the south, south-east, or south-west, then it is very likely it will not keep long, but be muddy and stale: Therefore, to keep beer in such a cellar, it should be brewed in October, that the drink may have time to care itself before the hot weather comes on; but, in wettest or damp cellars, it is best to brew in March, that the drink may have time to fine and settle before the winter weather is advanced. Now, cellars should have double or treble doors, that the outer one may be shut before the inner one is opened, to keep the air out. If a cellar be kept dry, and have double doors, it is reckoned warm in winter, and cool in summer. But the best of cellars are thought to be those in chalks, gravels, or

sands; and particularly in chalks, which are of a drying quality more than any other, and consequently dissipate damps; which contributes much to the good keeping of the drink, for all damp cellars are prejudicial to the preservation of beers and ales, and sooner bring on the rotting of the casks and hoops than the dry ones. Besides, in such inclosed cellars and temperate air, the beers and ales ripen more kindly, are better digested and softened, and drink smoother: But, when the temperature of the air in the cellar is unequal, the drink soon grows stale. Though malt-liquor be truly brewed, yet it is often spoiled in a bad cellar, that occasions such alternate fermentations as to make it thick and sour, though it sometimes happens that after such changes it fines itself again. To prevent these commotions of the beer, some brew their pale malt in March, and their brown in October; because the pale malt, having not so many fiery particles in it as the brown, stands more in need of the summer's weather to ripen it, while the brown sort, being more hard and dry, is better able to defend itself against the winter-colds that will help to smooth its harsh particles; yet, when they happen to be too violent, horse-dung should be laid to the windows as a fortification against them.

Some are of opinion, that October is the best of all other months to brew any sort of malt in, by reason there are so many cold months directly following, that will digest the drink and make it much excel that brewed in March, because such beer will not want that care and watching, as that brewed in March absolutely requires, by often taking out and putting in the vent-peg on change of weather; and, if it is always left out, then it deadens and palls the drink; yet, if due care is not taken in this respect, a thunder or stormy night may marr all, by making the drink ferment and burst the cask; for which reason, as iron hoops are most in fashion at this time, they are certainly the greatest security to the safety of the drink thus exposed; and next to them is the chestnut-hoop; both which will endure a shorter or longer time, as the cellar is more or less dry, and according to the management attending them: The iron hoops generally begin to rust first at the edges, and therefore should be rubbed off, and be kept from wet as much as possible.

*Of Cleaning and Sweetening of Casks.*

IN case your cask is a butt, then with cold water rinse out the lees clean, and have ready boiling or very hot water, which put in, and, with a long stale and a little birch fastened to its end, scrub the bottom as well as you can: At the same time let there be provided another shorter broom of about a foot and a half long, that with one hand may be so employed in the upper and other parts as to clean the cask well: So in a hoghead, or other smaller vessel, the one-handed short broom may be used with water, or with water, sand, or ashes, and be effectually cleaned; the outside of the cask about the bung-hole should be well washed, lest the yeast, as it works over, carry some of its filth with it.

But, to sweeten a barrel, kilderkin, firkin, or pin, in the great brewhouses, they put them over the copper-



hole for a night together, that the steam of the boiling water or wort may penetrate into the wood; this way is such a furious searcher, that unless the cask is new-hooped just before, it will be apt to fall to pieces.

*Another Way.*

TAKE a pottle, or more, of stone-lime. and put it into the cask; on this pour some water, and stop it up directly, shaking it well about.

*Another Way.*

TAKE a long linen rag, and dip it in melted brimstone; light it at the end, and let it hang pendant with the upper part of the rag fastened to the wooden bung; this is a most quick and sure way, and will not only sweeten, but help to fine the drink.

*Another.*

OR, to make your cask more pleasant, you may use the vintners way thus: Take four ounces of stone brimstone, one ounce of burnt allum, and two ounces of brandy; melt all these in an earthen pan over hot coals, and dip therein a piece of new canvas, and instantly sprinkle thereon the powders of nutmegs, cloves, coriander, and anise seeds: this canvas set on fire, and let it burn hanging in the cask fastened at the end with the wooden bung, so that no smoke comes out.

*For a musty Cask.*

BOIL some pepper in water, and fill the cask with it scalding hot.

*To prepare a new Vessel to keep Malt-liquors in.*

A NEW vessel is most improperly used by some ignorant

people for strong drink, after only once or twice scalding with water; which is so wrong, that such beer or ale will not fail of tasting thereof for half, if not a whole year afterwards. To prevent this inconvenience, when your brewing is over, put up some water scalding hot, and let it run through the grains; then boil it and fill up the cask, stop it well, and let it stand till it is cold; do this twice; then take the grounds of strong drink and boil in it green walnut-leaves and new hay or wheat-straw, and put all into the cask, that it be full, and stop it close: After this, use it for small beer half a year together, and then it will be thoroughly sweet and fit for strong drinks.

*Wine-casks.*

THESE are the cheapest of all others to furnish a person readily with, as being many of them good casks for malt-liquors, because the sack and white-wine sorts are already seasoned to hand, and will greatly improve beers and ales that are put in them: But beware of the Rhenish wine casks for strong drinks; for its wood is so tinctured with this sharp wine, that it will hardly ever be free of it; and therefore such cask is best used for small beer: the claret cask will a great deal sooner be brought into a serviceable state for holding strong drink, if it is two or three times scalded with grounds of barrels, and afterwards used for small beer for some time. But to cure a claret-cask of its colour and taste, put a peck of stone-lime into a hoghead, and pour upon it three pails of water; bung immediately with a wood or cork-bung, and shake it well about a quarter of an hour, and let it stand a day and night, and it will bring off the red colour, and alter the taste of the cask very much.

## B R E

**BREY**, a town of the bishopric of Liege, in Germany, about sixteen miles north of Maestricht; E. long.  $5^{\circ} 40'$ , and N. lat.  $51^{\circ} 15'$ .

**BREYNIA**, in botany, a synonyme of the cappariz. See **CAPPARIZ**.

**BRIANCON**, a town of Dauphiny, in France, situated about forty-five miles south-east of Grenoble; E. long.  $6^{\circ} 20'$ , and N. lat.  $44^{\circ} 50'$ .

**BRIAR**, in botany, the English name of a species of rosa. See **ROSA**.

**BRIARE**, a town of the Isle of France, situated on the river Loire, about seventy-five miles south of Paris; E. long.  $2^{\circ} 45'$ , and N. lat.  $47^{\circ} 40'$ .

**BRIBE**, a gift given to a person for doing or forbearing; any action that he ought to do or forbear.

**BRIBERY**. See **LAW**.

**BRICIANI**, those of the order of that name. This was a military order, instituted by St Bridget, queen of Sweden, who gave them the rules and constitutions of those of Malta and St Augustin. This order was approved by pope Urban V. They were to fight for the burying of the dead, to relieve and assist widows, orphans, the lame, sick, &c.

## B R I

**BRICK**, a fat reddish earth, formed into long squares, four inches broad, and eight or nine long, by means of a wooden mould, and then baked or burnt in a kiln, to serve the purposes of building.

Bricks are of great antiquity, as appears by the sacred writings, the tower and walls of Babylon being with them.

In the east, they baked their bricks in the sun; the Romans used them unburnt, only leaving them to dry for four or five years in the air.

The Greeks chiefly used three kinds of bricks; the first whereof was called [*didron*], i. e. of two palms; the second, [*tetradron*], of four palms; the third, [*pentadron*], of five palms. They had also other bricks, just half each of those, to render their works more solid, and also more agreeable to the sight, by the diversities of the figures and sizes of the bricks.

Pliny says, that to make good bricks they must not consist of any earth that is full of sand or gravel, nor of such as is gritty or stony; but of a greyish marl, or whitish chalky clay, or at least of a reddish earth: He also adds, that the best season for making bricks is the spring; because, if made in summer, they will

be:

be subject to crack, and be full of chinks. He directs, that the loam of which bricks are made be well steeped and wrought with water.

**BRICKS**, among us, are various, according to their various forms, dimensions, uses, method of making, &c. the principal of which are, Compass-bricks, of a circular form, used in steining of walls: Concave, or hollow bricks, on one side flat like a common brick, on the other hollowed, and used for conveyance of water: Feather-edged bricks, which are like common statute bricks, only thinner on one edge than the other, and used for penning up the brick pannels in timber buildings: Cogging bricks are used for making the indented works under the capping of walls built with great bricks: Capping bricks, formed on purpose for capping of walls: Dutch or Flemish bricks, used to pave yards, stables, and for soap-boilers vaults and cisterns: Clinkers, such bricks as are glazed by the heat of the fire in making: Sandel or famel-bricks, are such as lie outmost in a kiln, or clamp, and consequently are soft and useless, as not being thoroughly burnt: Great bricks are those twelve inches long, six broad, and three thick, used to build fence-walls: Plaster or buttress bricks, have a notch at one end, half the breadth of the brick; their use is to bind the work which is built of great bricks: Statute-bricks or small common bricks, ought, when burnt, to be nine inches long, four and a quarter broad, and two and a half thick; they are commonly used in paving cellars, sinks, hearths, &c.

Bricks are burnt either in a kiln or clamp. Those that are burnt in a kiln, are first set or placed in it, and then the kiln being covered with pieces of bricks, they put in some wood to dry them with a gentle fire; and this they continue till the bricks are pretty dry, which is known by the smoke's turning from a darkish colour to a transparent smoke: They then leave off putting in wood, and proceed to make ready for burning, which is performed by putting in brush, furze, spray, heath, brake, or fern-faggots; but before they put in any faggots, they dam up the mouth or mouths of the kiln with pieces of bricks (which they call *shinlog*) piled up one upon another, and close it up with wet brick-earth, instead of mortar.

The shinlog they make so high, that there is but just room above it to thrust in a faggot; then they proceed to put in more faggots, till the kiln and its arches look white, and the fire appears at the top of the kiln; upon which they slacken the fire for an hour, and let all cool by degrees. This they continue to do, alternately heating and slacking, till the ware be thoroughly burnt, which is usually effected in forty-eight hours.

About London they chiefly burn in clamps, built of the bricks themselves, after the manner of arches in kilns, with a vacancy between each brick, for the fire to play through; but with this difference, that instead of arching, they span it over by making the bricks project one over another on both sides of the place, for the wood and coals to lie in till they meet, and are bounded by the bricks at the top, which close all up.

The place for the fuel is carried up strait on both sides, till about three feet high; then they almost fill it with wood, and over that lay a covering of sea-coal, and then overspan the arch; but they strew sea-coal also over the clamp, betwixt all the rows of bricks; lastly, they kindle the wood, which gives fire to the coal; and when all is burnt, then they conclude the bricks are sufficiently burnt.

*Oil of BRICKS*, olive oil imbibed by the substance of bricks, and afterwards distilled from it. This oil was once in great repute for curing many diseases, but is now entirely laid aside.

**BRICKING**, among builders, the counterfeiting of a brick-wall on plaster, which is done by smearing it over with red ochre, and making the joints with an edged tool; these last are afterwards filled with a fine plaster.

**BRIDE**, a woman newly married. Among the Greeks it was customary for the bride to be conducted from her father's house to her husband's in a chariot, the evening being chosen for that purpose, to conceal her blushes; she was placed in the middle, her husband sitting on one side, and one of her most intimate friends on the other; torches were carried before her, and she was entertained in the passage with a song suitable to the occasion. When they arrived at their journey's end, the axle-tree of the coach they rode in was burnt, to signify that the bride was never to return to her father's house. Among the Romans, when a bride was carried home to her husband's house, she was not to touch the threshold at her first entrance, but was to leap over it.

**BRIDEGROOM**, a man newly married, the spouse of the bride.

The Spartan bridegrooms committed a kind of rape upon their brides; for matters being agreed on between them two, the woman that contrived and managed the match, having shaved the bride's hair close to her skin, dressed her up in man's cloaths, and left her upon a mattress; this done, in came the bridegroom, in his usual dress, having supped as ordinary, and stealing as privately as he could to the room where the bride lay, and untying her virgin-girdle, took her to his embraces; and having stayed a short time with her, returned to his companions, with whom he continued to spend his life, remaining with them by night as well as by day, unless he stole a short visit to his bride, which could not be done without a great deal of circumspection, and fear of being discovered.

**BRIDEWELL**, a work-house, or place of correction for vagrants, strumpets, and other disorderly persons.

These are made to work, being maintained with cloathing and diet; and when it seems good to their governors, they are sent by passes into their native countries; however, while they remain here, they are not only made to work, but, according to their crimes, receive, once a fortnight, such a number of stripes as the governor commands. Yet to this hospital several hopeful and ingenious lads are put apprentices, and prove afterwards honest and substantial citizens.

**BRIDGE**, a work of masonry or timber, consisting of one

one or more arches, built over a river, canal, or the like, for the conveniency of crossing the same.

Bridges are a sort of edifices very difficult to execute, on account of the inconvenience of laying foundations, and walling under water. The parts of a bridge are the piers, the arches; the pavement, or way over for cattle and carriages; the foot-way on each side, for foot passengers; the rail or parapet, which incloses the whole; and the butments or ends of the bridge on the bank.

The conditions required in a bridge are, that it be well-designed, commodious, durable, and suitably decorated. The piers of stone-bridges should be equal in number, that there may be one arch in the middle, where commonly the current is strongest; their thickness is not to be less than a sixth part of the span of the arch, nor more than a fourth; they are commonly guarded in the front with angular sterlings, to break the force of the current: the strongest arches are those whose sweep is a whole semicircle; as the piers of bridges always diminish the bed of a river, in case of inundations, the bed must be sunk or hollowed in proportion to the space taken up by the piers (as the waters gain in depth what they lose in breadth) which otherwise conduce to wash away the foundation and endanger the piers: To prevent this, they sometimes diminish the current, either by lengthening its course, or by making it more winding; or by stopping the bottom with rows of planks, stakes, or piles, which break the current. It is also required that the foundation of bridges be laid at that season of the year, when the waters are lowest; and if the ground be rocky, hard gravel, or stony, the first stones of the foundation may be laid on the surface; but if the soil be soft sand, it will be necessary to dig till you come to a firm bottom.

Among the bridges of antiquity, that built by Trajan over the Danube is allowed to be the most magnificent; it was composed of twenty arches, of an hundred and fifty feet in height, and their opening from one pier to another was an hundred and sixty feet: The piers of this fine bridge are still to be seen in the Danube, being erected between Servia and Moldavia, a little above Nicopolis.

Among modern bridges, that of Westminster, built over the river Thames, may be accounted one of the finest in the world: It is forty-four feet wide, a commodious foot-way being allowed for passengers, on each side, of about seven feet broad, raised above the road allowed for carriages, and paved with broad moor-stones, while the space left between them is sufficient to admit three carriages and two horses to go a-breast, without any danger. Its extent from wharf to wharf is 1220 or 1223 feet, being full three hundred feet longer than London-bridge. The free water-way under the arches of this bridge is eight hundred and seventy feet, being four times as much as the free water-way left between the sterlings of London-bridge: This disposition, together with the gentleness of the stream, are the chief reasons why no sensible fall of water can ever stop, or in the least

endanger the smallest boats in their passage through the arches.

It consists of thirteen large and two small arches, together with fourteen intermediate piers.

Each pier terminates with a saliant right angle against either stream: the two middle piers are each seventeen feet in thickness at the springing of the arches, and contain three thousand cubic feet, or near two hundred tons of solid stone; and the others decrease in width equally on each side by one foot.

All the arches of this bridge are semicircular; they all spring from about two feet above low-water mark; the middle arch is seventy-six feet wide, and the others decrease in breadth equally on each side by four feet.

This bridge is built of the best materials; and the size and disposition of these materials are such, that there is no false bearing, or so much as a false joint in the whole structure; besides that, it is built in a neat and elegant taste, and with such simplicity and grandeur, that, whether viewed from the water, or by the passengers who walk over it, it fills the mind with an agreeable surprize. The semioctangular towers, which form the recesses of the foot-way, the manner of placing the lamps, and the height of the balustrade, are at once the most beautiful, and, in every other respect, the best contrived.

But the most singular bridge in Europe is that built over the river Tave in Glamorganshire. It consists of one stupenduous arch, the diameter of which is 175 feet, the chord 140, the altitude 35, and the abutments 32. This magnificent arch was built by William Edward, a poor country-mason, in the year 1756.

Bridges are either built of stone or timber, as is judged most convenient.

**Stone-BRIDGES** consist of piers, arches, and butments, made of hewn stone, sometimes also intermixed with bricks.

**Wooden-BRIDGES** are composed of beams and joists, supported by punchions, well cramped and bound together.

**Rushen-BRIDGES** are made of great bundles of rushes, bound fast together, over which planks are laid, and fastened: these are put over marshy places, to serve for a crossing ground.

**Pendent or hanging-BRIDGES**, called also philosophical bridges, are those not supported by posts or pillars, but hung at large in the air, sustained only at the two ends or butments.

**Draw-BRIDGE**, one that is fastened with hinges at one end only, so that the other may be drawn up; in which case, the bridge stands upright, to hinder the passage of a ditch or moat.

**Flying or floating BRIDGE**, is generally made of two small bridges, laid one over the other in such a manner, that the uppermost stretches and runs out, by help of certain cords, running through pulleys placed along the sides of the under bridge, which push it forwards, till the end of it joins the place it is intended to be fixed on.

**BRIDGE of boats**, boats made of copper, and joined side by side, till they reach a-cross a river, which being covered with planks, are fastened with stakes or anchors.

**BRIDGE of communication** is that made over a river, by which two armies, or forts, which are separated by that river, have a free communication with one another.

**Floating BRIDGE**, a bridge made use of, in form of a work in fortification, called a redoubt, consisting of two boats, covered with planks, which are solidly framed, so as to bear either horse or cannon.

**BRIDGE**, in gunnery, the two pieces of timber which go between the two transoms of a gun-carriage, on which the bed rests.

**BRIDGE**, in music, a term for that part of a stringed instrument over which the strings are stretched. The bridge of a violin is about one inch and a quarter high, and near an inch and a half long.

**BRIDGE-TOWN**, the capital of the island of Barbadoes: West lon.  $56^{\circ}$ , and North lat.  $13^{\circ}$ . It has commodious wharfs for unloading goods, also some forts and castles for the defence of the place.

**BRIDGE-NORTH**, a borough-town of Shropshire, situated on the river Severn, about fifteen miles south-east of Shrewsbury: West lon.  $2^{\circ} 30'$ , and North lat.  $52^{\circ} 40'$ . It sends two members to parliament.

**BRIDGEWATER**, a large borough-town of Somersetshire, situated near the mouth of the river Evil, in  $3^{\circ}$  West long. and  $51^{\circ} 15'$  North lat. It sends two members to parliament.

**BRIDLE**, in the menage, a contrivance made of straps or thongs of leather and pieces of iron, in order to keep a horse in subjection and obedience.

The several parts of a bridle are the bit, or snaffle; the head-stall, or leathers from the top of the head to the rings of the bit; the fillet, over the fore-head and under the fore-top; the throat-band, which burtons from the head-band under the throat; the reins, or long thongs of leather that come from the rings of the bit, and being cast over the horse's head, the rider holds them in his hand; the nose band, going through loops at the back of the head-stall, and buckled under the cheeks; the trench; the caveman; the martingal; and the chaff halter.

Bridles imported pay a duty of 4s.  $9\frac{4}{10}$ d. the dozen; whereof 4s.  $3\frac{7}{10}$ d. is repaid on exporting them again: besides which they also pay 6s. for every 20s. value upon oath, without any drawback.

**BRIDLE-HAND** is the horseman's left hand, the right hand being the spear or sword hand.

*To swallow the BRIDLE*, is said of a horse that has too wide a mouth, and too small a bit-mouth.

**BRIDON**, or **SNAFFLE**, after the English fashion, is a very slender bit-mouth, without any branches. The English make much use of them, and scarcely use any true bridles, except in the service of war. The French call them bridons, by way of distinction from bridles.

**BRIDPORT**, a borough and port-town of Dorsetshire, situated about ten miles west of Dorchester; W. long.  $3^{\circ}$ , and N. lat.  $50^{\circ} 40'$ .

It sends two members to parliament.

**BRIEF**, in Scots law, a writ issued from the chancery, directed to any judge-ordinary, commanding and authorising that judge to call a jury to inquire into the case mentioned in the brief, and upon their verdict to pronounce sentence.

**Apostolical BRIEFS**, letters which the pope dispatches to princes, or other magistrates, relating to any public affair.

These briefs are distinguished from bulls, in regard the latter are more ample, and always written on parchment, and sealed with lead or green wax; whereas briefs are very concise, written on paper, sealed with red wax, and with the seal of the fisherman, or St Peter in a boat.

**BRIEG**, a town of Silesia, about twenty miles south-east of Breslaw; E. long.  $17^{\circ} 20'$ , and N. lat.  $50^{\circ} 50'$ .

**BRIENNOIS**, the southern division of the duchy of Burgundy, in France.

**BRIEUX**, a port-town of Britany, in France, situated on the English channel, about thirty miles west of St Malo; W. long.  $2^{\circ} 50'$ , and N. lat.  $48^{\circ} 40'$ .

**BRIGADE**, in the military art, a party or division of a body of soldiers, whether horse or foot, under the command of a brigadier.

An army is divided into brigades of horse and brigades of foot: a brigade of horse is a body of eight or ten squadrons; a brigade of foot consists of four, five, or six battalions.

The eldest brigade has the right of the first line, and the second the right of the second, and the two next take the left of the two lines, and the youngest stand in the centre.

**BRIGADE-MAJOR**, is an officer appointed by the brigadier, to assist him in the management and ordering of his brigade.

**BRIGADIER** is the general officer who has the command of a brigade. The eldest colonels are generally advanced to this post. He that is upon duty is brigadier of the day. They march at the head of their own brigades, and are allowed a serjeant and ten men of their own brigade for their guard.

**BRIGADIERS**, and **SUB-BRIGADIERS**, are posts in the horse-guards.

**BRIGANDINE**, a coat of mail, a kind of ancient defensive armour, consisting of thin jointed scales of plate, pliant and easy to the body.

**BRIGANTINE**, a small light vessel, which can both row and sail well, and is either for fighting or giving chase. It hath about twelve or fifteen benches for the rowers, one man to a bench; all the heads aboard are soldiers, and each man hath his musquet lying ready under his oar.

**BRIGG**, a market-town in Lincolnshire, about twenty-four miles north of Lincoln; W. long.  $20'$ , and N. lat.  $53^{\circ} 40'$ .

**BRIGHTHELMSTONE**, a little port-town in Sussex, about seven miles south-west of Lewes; W. long.  $10'$ , and N. lat.  $50^{\circ} 50'$ .

**BRIHUEGA**, a town of New Castile, in Spain, about forty-three miles north-east of Madrid; W. long.  $3^{\circ} 20'$ , and N. lat.  $41^{\circ}$ .

**BRILL**,

**BRILL**, or **BRIEL**, the capital of the island of Voorn, in Holland, situated about twelve miles south of the Hague; E. long. 4°, and N. lat. 51° 50'.

**BRILLIANT**, in a general sense, something that has a lucid and bright appearance.

**BRILLIANT**, in the menage, a brisk, high-mettled, stately horse, is called brilliant, as having a raised neck, a fine motion, excellent haunches, upon which he rises, though never so little put on.

**BRIM** denotes the utmost verge or edge, especially of round things.

**BRIM**, in country affairs. A sow is said to brim, or to go to brim, when she is ready to take boar.

**BRIMSTONE**. See **SULPHUR**, and **CHEMISTRY**.

**BRIMSTONE-marble**. See **MARBLE**.

**BRIN**, a city of Moravia, dependent on Bohemia, about thirty miles south-west of Olmutz: E. long. 16° 20', and N. lat. 49° 40'.

**BRINDISI**, a port-town of the kingdom of Naples, situated on the gulph of Venice, about thirty-five miles north-west of Otranto; E. long. 18° 45', and N. lat. 40° 40'.

**BRINE**, water replete with saline particles; or pickle.

**BRINE-water**, a salt water, which being boiled, turns into salt.

Brine taken out of brine-pits, or brine-pans, used by some for curing or pickling of fish, without boiling the same into salt, and rock-salt without refining it into white-salt, are prohibited by 1 Anne, cap. xxi.

**BRINGING-IN a horse**, in the menage, the same as to say, keep down the nose of a horse that boars, and tosses his nose in the wind; this is done by means of a good branch. See **BANQUET**, and **WIND**.

**BRION**, an island of North America, in the gulph of St Lawrence.

**BRIONES**, a small town of Old Castile, in Spain, situated on the river Ebro.

**BRIONI**, the name of three islands in the Adriatic sea, upon the western coast of Istria. They belong to the Republic of Venice.

**BRIONNE**, a town of Normandy, in France, situated on the Rill, about ten leagues from Rouen.

**BRISAC**, a fortified town of Swabia, in Germany, situated on the eastern shore of the river Rhine, about thirty miles north of Strasburg; E. long. 7° 15', and N. lat. 48° 10'.

*New* **BRISAC**, a fortress on the western shore of the Rhine, opposite to Old Brisac. It is situated in Alsace, and belongs to the French.

**BRISGOW**, a territory of the circle of Swabia, in Germany, situated on the east side of the Rhine, opposite to the Upper Alsace, whereof Fribourg and Brisac are the chief towns.

**BRISTLE**, a rigid glossy kind of hair, found on swine, and much used by brushmakers, &c.

Bristles, rough and undressed, pay a duty of 1s. 2½d. the dozen pound, whereof 1s. 2½d. is drawn back on exporting them; whereas dressed bristles pay a duty of 2s. 4½d. the dozen pound, whereof 2s. 1½d. is drawn back on exportation.

The whiskers of cats are also sometimes called bristles; as are the quills of the porcupine.

**BRISTOL**, a city and port-town of England, situated partly in Gloucestershire, and partly in Somersetshire; W. long. 2° 40', and N. lat. 51° 30'.

It stands on the river Avon, about ninety miles west of London, and is a town of the greatest foreign trade of any in Britain next to London. It is also a bishop's see, sends two members to parliament, and gives the title of earl to the noble family of Harvey.

*New* **BRISTOL**, the capital of the county of Bucks, in Pennsylvania, about twenty miles north of Philadelphia. It is situated on the river Delawar, in 75° W. long. and 40° 45' N. lat.

**BRISTOL-water**. These waters are the fourth in degree amongst the waters which are esteemed warm. The waters of Bath are the first, Buxton the second, and Matlock the third.

Bath waters are beneficial, when the secretions from the blood are diminished; Bristol, when too much increased: Bath attenuates powerfully; Bristol increases: Bath is spirituous, and helps defects; Bristol is more cooling, and suppresses plentitude, with its consequences, inflammations and hæmorrhages.

If we may judge of the contents of Bristol waters, from their effects, which are exceedingly deterfive and healing; they partake chiefly of chalk, lapis calcarius, and calaminaris, the virtues of which are too dry to cleanse; they fill ulcers with flesh, and cicatrize them.

But whatever the substances are that impregnate them, it is plain they are very subtle, and that there is but little of a terrestrial part in them, from their specific lightness above other waters: Yet when we consider how agreeable to the sight, smell and taste; how clear, pure and soft they are; their gentle degree of heat, so-adapted to sundry diseases; it must be concluded, that those waters do imbibe some salutary particles in their passage through the earth; and; from the many cures yearly wrought by them, that they have an undoubted title to a place in the first class of medicinal waters.

The diseases in which Bristol waters are properly prescribed, are internal hæmorrhages and inflammations, blood-spitting, dysentery, and immoderate flux of the menses, purulent ulcers of the viscera: Hence, in consumptions, the dropsy, scurvy with heat, stone, gravel, strangury; the habitual gout, scorbutic rheumatism, diabetes, slow fevers, atrophy, pox, cancer, gleets in both sexes, king's evil, &c.; in all these disorders, Bath waters are not only improper, but hurtful; they rouse the too languid, and quicken the too lazy circulation; they allay the heat, and restrain the too rapid motion of the blood. Those impregnate the phlegmatic, these attemperate the choleric constitution. Bath water seems to be adapted to the maladies of the stomach, guts, and nerves; Bristol; to those of the lungs, kidneys, and bladder: Again, Bath waters are at variance with a milk course; and the Bristol can never be judiciously directed, but when they may be joined with reason and success.

The

- The Bristol waters are taken medicinally only during the hot months, as from April to September.
- BRISTOL-flower**, in botany, a name sometimes given to the lichen. See **LICHNIS**.
- BRITAIN**, or **GREAT-BRITAIN**, the most considerable of all the European islands, lies between  $50^{\circ}$  and  $60^{\circ}$  N. lat. and between  $2^{\circ}$  E. long. and  $6^{\circ}$  W. long.
- The general division of Britain, is into South and North Britain, or England and Scotland.
- New BRITAIN**, a large country of North America, called also Terra Labrador, has Hudson's bay and strait on the north and west; Canada and the river of St Lawrence, on the south; and the Atlantic ocean on the east.
- It is subject to Great-Britain, but yields only skins and furs.
- BRITANNICA**, in botany, the trivial name of a species of Rumex. See **RUMEX**.
- BRITANY**, a province of France, surrounded by the English channel and the bay of Biscay, on the north, west, and south; and bounded on the east by the province of Orleans.
- BRITE**, or **BRIGHT**, in husbandry. Wheat, barley, or any other grain, is said to brite, when it grows over-ripe, and shatters.
- BRITTLENESS**, that quality of bodies, on account of which they are denominated brittle, or which subjects them to be easily broken.
- Brittle bodies are likewise very hard and durable, barring accidents; and it is remarkable, that tin, though tough in itself, makes all other metals brittle, when mixed with them.
- BRIVE LA GAILLARDE**, a town of France in the Limousin, upon the Coureze.
- BRIXEN**, a city of Tyrol in Germany, about fifty miles north-east of Trent: E. long.  $11^{\circ} 45'$ , N. lat.  $46^{\circ} 45'$ .
- BRIZA**, a genus of the triandria digynia class. There are five species of Briza, two of which are natives of Britain, viz. the media or middle quaking grass, and the minor or small quaking-grass. They grow in pasture-grounds.
- BRIZE**, in husbandry, denotes ground that has lain long untilled.
- BRIZE-vents**, shelters used by gardeners who have not walls on the north-side, to keep cold winds from damaging their beds of melons. They are inclosures about six or seven feet high, and an inch or more thick; made of straw, supported by stakes fixed into the ground, and props across on both inside and outside; and fastened together with willow twigs, or iron-wire.
- BROADALBIN**, a district or county of Perthshire, in Scotland, bordering upon Argyleshire: It gives the title of earl to a branch of the noble family of Campbell.
- BROAD-side**, in the sea-language, denotes a volley of cannon, or a general discharge of all the guns on one side of a ship at once.
- BROCADE**, or **BROCADE**, a stuff of gold, silver, or silk, raised and enriched with flowers, foliages, and other ornaments, according to the fancy of the merchants or manufacturers.
- Formerly the word signified only a stuff, wove all of gold, both in the warp and in the woof, or all of silver, or of both mixed together; thence it passed to those of stuffs in which their was silk mixed, to raise and terminate the gold or silver flowers: But at present all stuffs, even those of silk alone, whether they be programs of Tours or of Naples, sattins, and even taffeties or lustrings, if they be but adorned and worked with some flowers, or other figures, are called brocades.
- BROCADE-shell**, the English name of a species of limax. See **LIMAX**.
- BROCADEL**, or **BROCADEL**, a kind of coarse brocade; chiefly used for tapestry.
- BROCCOLI**, a kind of cabbage cultivated for the use of the table; the manner of dressing which is this: When their heads are grown to their full bigness, they are to be cut off, with about four inches of the tender stem; the outer skin is then to be stripped off the stem, after which they are to be washed, and boiled in a clean linnen cloth, as is practised for cauliflowers.
- They are tenderer than any cauliflower, though very like them in taste.
- BROCK**, among sportsmen, a term used to denote a badger.
- A hart too of the third year is called a brock, or brocket; and a hind of the same year, a brocket's sister.
- BROD**, a town of Sclavonia, situated on the river Save, about sixteen miles south of Pofega: E. long.  $18^{\circ} 50'$ , N. lat.  $45^{\circ} 20'$ .
- BRODERA**, or **BRODRA**, a city of Asia, in the country of the Mogul and kingdom of Guzurat, where there is a great trade in cotton cloths: E. long.  $73^{\circ} 30'$ , N. lat.  $22^{\circ} 25'$ .
- BRODIUM**, a pharmaceutical term, signifying the same as julecolum, or the liquor in which some solid medicine is preserved, or with which something else is diluted.
- BROGLING for eels**, the same with snigglng. See **SNIGGLING**.
- BROGLIO**, a town of Peidmont in Italy, situated near the frontiers of Provence, about twenty five miles north-west of Nice: E. long.  $6^{\circ} 42'$ , N. lat.  $44^{\circ} 12'$ .
- It is the capital of a county of the same name.
- BROITSCHIA**, a city of Asia in Indostan, about twelve leagues from Surat.
- BROKEN wind**, among farriers, is a malady that happens to a horse when he is suffered to stand too long in the stable, without exercise: By this means he contracts gross and thick humours in such abundance, that, adhering to the hollow parts of his lungs, they stop his wind-pipe.
- This distemper is known by the horse's heaving and drawing up his flanks together, and blowing wide his nostrils.
- To cure this disorder, take the guts of a hedge-hog, dry

dry them, and pound them to powder, and give the horse two or three spoonfuls of it in a pint of wine or strong ale; then mix the rest with anise-feed, liquorice, and sweet butter, of which make round balls, or pills, and give him two or three of them after drink, and let him fast two or three hours.

**BROKER**, a name given to persons of several and very different professions, the chief of which are exchange-brokers, stock-brokers, pawn-brokers, and brokers, simply so called, who sell household-furniture, and second-hand apparel.

**Exchange-BROKERS** are a kind of agents, or negotiators, who contrive, propose, and conclude bargains between merchants, and between merchants and tradesmen, in matters of bills of exchange, or merchandise, for which they have so much commission. These, by the statute of 8 and 9 William III. are to be licensed in London by the Lord Mayor, who gives them an oath, and takes bond for the faithful execution of their offices. If any person shall act as broker, without being thus licensed and admitted, he shall forfeit the sum of 500 l. and persons employing him 5 l. and brokers are to register contracts, &c. under the like penalty: Also brokers shall not deal for themselves, on pain of forfeiting 200 l. They are to carry about with them a silver medal, having the king's arms, and the arms of the city, and pay 40s. a year to the chamber of the city.

The exchange brokers make it their business to know the alteration of the course of exchange, to inform merchants how it goes, and to give notice to those who have money to receive or pay beyond sea; they are the proper persons for negotiating the exchange, and when the matter is accomplished, that is, when the money for the bill is paid, and the bill delivered, they have for brokerage 2 s. for 100 l. sterling.

They reckon at Paris, among the city-officers, who are employed under the jurisdiction of the provost of the merchants, and *eschevins* or aldermen, three sorts of brokers.

1. The brokers of horses for the carriage of merchandise by water; they are established for the navigation, and take care to examine the horses used to draw the boats up the river; to set the horses together, to oblige the carriers to repair their boats, or to break such as are no longer fit to serve.

2. Sworn wine-brokers on the keys, to examine and taste all the wine that arrives there.

3. Brokers of bacon and lard. These are established to examine those sorts of merchandises, as they are landed or unloaded, and to answer for their goodness to the buyer, and to the seller, for the price of his wares.

**Stock-BROKERS**, are those who are employed to buy and sell shares in the joint stock of a company, or corporation.

As the practice of stock-jobbing has been carried on to such an excess as became not only ruinous to a great number of private families, but even affected, or at least might soon affect, the public credit of the nation, the legislature thought fit to put a stop to it, or at

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least to bring it within certain bounds, and under some regulation, by statute 7 George II. c. viii. sect. 1.

**PAWN-BROKERS**. Persons who keep shops, and lend money upon pledges to necessitous persons, and most commonly at an exorbitant interest. They are more properly styled pawn-takers, or tally-men, sometimes fripers, or friperers. These are meant in 1 Jac. I. cap. xxi. sect. 5. where it is declared, that the sale of goods wrongfully taken to any broker, or pawn-broker in London, Westminster, Southwark, or within two miles of London, does not alter the property.

And sect. 7. If a broker, having received such goods, shall not, upon request of the owner, discover them, how and when he came by them, and to whom they are conveyed, he shall forfeit the double value thereof, to be recovered by action of debt, &c.

In the cities of Italy, there are companies established by authority for the letting out money on pawns, called *mounts of piety*; a title little becoming such institutions, as the loan is not gratis. In some parts of Italy, they have also mounts of piety of another kind, wherein they only receive ready money, and return it again with interest, at a certain sum *per annum*.

At Bologna, they have several such mounts, which are distinguished into frank and perpetual; the interest of the former is only four *per cent.* that of the latter, seven.

**BROKERS** are also those who sell old household-furniture, and wearing apparel, &c.

**BROMELIA**, or pine apple, in botany, a genus of the hexandria monogynia class. The calix is divided into three segments; it has three petals, and there is a scaly nectarium at the base of each petal; the berry has three cells. There are five species of bromelia, viz. the ananas or common pine-apple, which is a native of Surinam and New Spain; the pinguin, a native of Jamaica and Barbadoes; the karatos, *lingulata*, and *nudicaulis*, all natives of the southern parts of America.

**BROMSGROVE**, a market-town in Worcestershire, about ten miles north of Worcester: W. long. 2° 5', N. lat. 52° 26'.

**BROMLEY**, a market-town of Kent, ten miles south-east of London: E. long. 5', N. lat. 51° 25'.

**BROMLEY** is also the name of a market-town of Staffordshire, about ten miles east of Stafford: W. long. 1° 50', N. lat. 52° 45'.

**BROMOIDES**, in botany. See **FESTUCA**.

**BROMUS**, in botany, a genus of the triandria digynia class. The calix is double-valved; the spica is oblong and cylindrical; the awn is below the apex. There are 17 species, eight of which are natives of Britain, viz. the *secalinus* or field brome-grass, the *arvensis* or corn brome-grass, the *ciliatus* or wall brome-grass, the *sterilis* or barren brome-grass, the *giganteus* or tall brome-grass, the *ramosus* or wood brome-grass, and the *pinnatus* or spiked brome-grass.

**BRONCHIA**, in anatomy, the ramifications of the trachea. See p. 280. (col. 2.) & p. 281.

**BRONCHOCELE**, in surgery, a tumour arising in the anterior part of the neck. See **SURGERY**.

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**BRONCHOTOMY**, in surgery, an incision made in the aspera arteria, or wind-pipe, which is necessary in many cases, and especially in a violent quinsy, to prevent suffocation from the great inflammation or tumor of the parts. It is also called laryngotomy and tracheotomy. See **SURGERY**.

**BRONCHIÆ**, according to Galen, is the aspera arteria which reaches from the larynx to the lungs, consisting of the bronchia.

Sometimes it is put for the whole aspera arteria; and Hippocrates uses it to signify the throat.

**BRONTIÆ**, or **THUNDER-STONES**, in natural history. See **BELEMNITES**.

**BRONTIUM**, in Grecian antiquity, a place underneath the floor of the theatres, in which were kept brazen vessels full of stones and other materials, with which they imitated the noise of thunder.

**BRONTOLOGY** denotes the doctrine of thunder, or an explanation of its causes, phenomena, &c. together with the presages drawn from it. See **THUNDER**, and **ELECTRICITY**.

**BRONZE**, a compound metal, consisting of one part of tin, ten of copper, and a little zinc. See **CHEMISTRY**.

**BRONZES**, a name given by antiquarians to figures either of men or beasts, to urns, and, in general, to every piece of sculpture which the ancients made of that metal. We likewise give the name of bronzes to statues or busts cast of bronze, whether these pieces be copies of antiques, or original subjects.

Among medallists, all copper medals bear the name of bronze.

**BRONZING**, the art of varnishing wood, plaster, ivory, &c. so as to give them the colour of bronze. See **VARNISHING**.

**BROOD**, the young of fish, fowls, &c.

**BROODING**, the act of a hen in hatching her eggs. See **HATCHING**.

**BROOK**, a little river or small current of water.

A brook is distinguished from a river inasmuch as a river flows at all times, whereas a brook flows at some particular seasons only.

**BROOK-LIME**. See **ANAGALLIS**.

**BROOM**, in botany. See **GENISTA**.

**Butchers-BROOM**, the English name of the ruscus. See **SPARTIUM**.

**Spanish-BROOM**, in botany. See **SPARTIUM**.

**BROOM-FLOWER**, *ordre de la geniste*, an order instituted by St Louis, king of France, to shew the esteem which he had for the queen his wife, who, the evening before his queen's coronation, received this order himself.

**BROOM-RAPE**, in botany. See **OROBANCHE**.

**BROOMING**, or **BREAMING**, of a ship, the washing and burning off all the filth that she has contracted on her sides with weeds, straw, broom, or the like, when she is on the careen, or on the ground. See **CAREENING**.

**BROTHEL**. See **STREWS**.

**BROTHER**, a term of relation between male children, sprung from the same parents, or from the same father, or the same mother.

The ancients used the term brother, indifferently, to almost all who stood related in the collateral line, as uncles and nephews, cousins-german, &c.

According to the laws of Moses, the brother of a man, who died without children, was obliged to marry the widow of the deceased, in order to raise up children to him, that his name and memory might not be extinct. See the article **WIDOW**.

Among us, it is customary for kings to give the title brother to each other.

In the civil law, brothers, *fratres*, in the plural number, sometimes comprehends sisters.

**BROTHER** is also a customary term for priests of the same persuasion to address one another by; but it is more particularly used to denote the relation between monks of the same convent, as father Zachary: In English, we more usually say, Frar Zachary, from the French word *frere*, brother. Preachers also call their hearers, my brethren, or my dear brethren; and sometimes they use the singular number, and say, my brother.

This appellation is borrowed from the primitive Christians, who all called each other brothers: but it is now principally used for such of the religious as are not priests; those in orders are generally honoured with the title of father, whereas the rest are only simply brothers.

**BROTHERS-GERMAN**. See **GERMAN**.

**BROTHERS of the rosy-cross**. See **ROSICRUCIAN**.

**BROUCK**, the name of a town of Germany, in the circle of Westphalia, upon the river Roer; and likewise of a town of Switzerland, upon the banks of the Aar.

**BROUERSHAVEN**, a port-town of Zeland, in the united Netherlands, situated on the north side of the island of Schonen, about nine miles south-west of Helvoetsluys: E. lon. 3° 55', and N. lat. 51° 50'.

**BROW**, or **EYE-BROW**, an hairy arch extended over the orbit of each eye. See p. 291. col. 1.

**BROW-POST**, among builders, denotes a beam which goes across a building.

**BROW-ANTLER**, among sportsmen, that branch of a deer's horn next the tail.

**BROWALLIA**, in botany, a genus of the didynamia angiospermia class. The calix has five teeth; the limbus of the corolla is divided into five equal and open segments; and the capsule is unilocular.

**BROWN**, among dyers, painters, &c. a dusky colour, inclining towards redness. Of this colour there are various shades or degrees, distinguished by different appellations; for instance, Spanish-brown, a sad-brown, a tawney-brown, the London-brown, a clove-brown, &c.

Spanish-brown is a dark dull red, of a horse-lesh colour. It is an earth, and is of great use among painters, being generally used as the first and priming colour that they lay upon any kind of timber-work in house-painting. That which is of the deepest colour, and freest from stones, is the best. Though this is of a dirty brown colour, yet it is much used, not to colour any garment, unless it be an old man's gown;



gown; but to shadow vermilion, or to lay upon any dark ground behind a picture, or to shadow yellow berries in the darkest places, when you want lake, &c. It is best and brightest when burnt in the fire, till it be red hot, although, if you would colour any hare, horse, dog, or the like, it should not be burnt; but, for other uses, it is best when it is burnt; as for instance, for colouring wood, posts, bodies of trees, or any thing else of wood, or any dark ground of a picture. See DYING.

**BROWNISTS**, in church-history, a religious sect, which sprung up in England towards the end of the XVIth century. Their leader was one Robert Brown, born at Northampton. They separated from the established church, on account of its discipline and form of government. They equally disliked episcopacy and presbyterianism. They condemned the solemn celebration of marriages in churches, maintaining, that matrimony being a political contract, the confirmation of it ought to proceed from the civil magistrate. They rejected all forms of prayer, and held, that the Lord's prayer was not to be recited as a prayer; being given only as a model, upon which to form our prayers.

**BRUCA**, the name of a river and sea-port town of Sicily, in the valley of Noto.

**BRUCHSAL**, a town of the bishopric of Spire, in the palatinate of the Rhine, in Germany: E. lon.  $8^{\circ} 30'$ , and N. lat.  $49^{\circ} 15'$ .

**BRUCHUS**, in zoology, a genus of insects belonging to the order of coleoptera. The feelers are filiform, and gradually increase in thickness. There are seven species, viz. the pisi, has grey elytra interspersed with white spots, and a white fundament with two black spots. It is a native of North America, and destroys whole fields of pease: It is now found in several of the southern parts of Europe; where it does great injury to the corn. 2. The theolromæ with whitish elytra interspersed with black points. It frequents the theolroma or chocolate trees in the East Indies. 3. The glediæ, with striated elytra of the same length with the belly, a pitch-coloured body, and green feelers. It is a native of America. 4. The bactris, with smooth elytra, a hoary body, and the hind part of the thighs oval. It frequents the palm-trees of Jamaica. 5. The granarius, has black elytra; the fore-feet are red, and the hind-feet are dentated. It frequents the seeds of plants in different parts of Europe. 6. The semiparius is black, with the base of the feelers and fore-feet testaceous. It is about the size of a louse, and a native of Europe. 7. The peccicornis, with comb-shaped feelers longer than the body. It is a native of Barbary and China.

**BRUGES**, a city and port-town of Flanders, eleven miles east of Ostend, and twenty-four north-west of Ghent: E. lon.  $3^{\circ} 5'$ , and N. lat.  $51^{\circ} 16'$ .

There is a navigable canal from Ostend to Bruges, which has still the best foreign trade of any town in Flanders.

**BRUISE**, in surgery, the same with contusion. See CONTUSION, and SURGERY.

**BRUMALIA**, in Roman antiquity, festivals of Bacchus celebrated twice a-year; the first on the twelfth of the calends of March, and the other on the eighteenth of the calends of November. They were instituted by Romulus, who, during these feasts, used to entertain the senate. Among other heathen festivals which the primitive Christians were much inclined to observe, Tertullian mentions the brumæ or brumalia.

**BRUNELLA**, in botany. See PRUNELLA.

**BRUNIA**, in botany, a genus of the pentandria monogynia class. The flowers are aggregated; the filaments of the stamina are inserted into the unguis of the petals; the stigma is bifid, and the seeds are single. There are six species, all natives of Æthiopia.

**BRUNSBUTTEL**, a port-town of Holstein, in the circle of Lower Saxony, in Germany, situated at the mouth of the river Elbe: E. lon.  $8^{\circ} 42'$ , and N. lat.  $54^{\circ} 10'$ . It is subject to Denmark.

**BRUNSFELSIA**, in botany, a genus of the pentandria monogynia class. The corolla is long and shaped like a tunnel; the berry is unilocular, and contains many seeds.

**BRUNSWICK**, the capital of the duchy of Brunswick, in the circle of Lower Saxony, in Germany, situated on the river Ocker, about 35 miles east of Hanover: E. lon.  $10^{\circ} 30'$ , and N. lat.  $52^{\circ} 30'$ .

The elector of Hanover is styled duke of Brunswick, though he has no property in, or dominion over, the city of that name, which belongs to the duke of Brunswick Wolfembutte.

**BURNTISLAND**, a parliament-town on the coast of Fife, in Scotland, about ten miles north-west of Edinburgh; W. long.  $3^{\circ}$ , and N. lat.  $56^{\circ} 12'$ .

**BRUSH**, an instrument made of bristles, hair, wire, or small twigs, to clean cloaths, rooms, &c. and also to paint with. There are various sorts of them, distinguished by their shape or use. In the choice of painters brushes, observe whether the bristles are fast bound in the stocks, and if the hair be strong and lie close together; for if they sprawl abroad, such will never work well; and if they are not fast bound in the stock, the bristles will come out when you are using them, and spoil your work, as may be seen where the loose hairs of the brush have lain up and down in the colours laid on, to the great detriment of the work.

Wine-brushes are of use for scrubbing those silver, copper, and brass pieces, which are to be gilded over, in order to clear them perfectly from any dirt, rust, or filth, which may adhere to them, and, if not brushed off, would hinder the closing of the gold with them. They are therefore used by gilders, silversmiths, &c. and are usually sold by ironmongers. Beard-brushes pay a duty, on importation, of 1s.  $3\frac{4}{8}$ d. the gross or twelve dozen; whereof 1s.  $1\frac{1}{2}$  is drawn back on exporting them. Comb-brushes pay 2s.  $6\frac{8}{10}$ d. for the same number; and of this 2s. 3d. is repaid. Head-brushes pay 1s.  $3\frac{4}{8}$ d. the dozen; rubbing-brushes  $3\frac{8}{10}$ d. the dozen; weavers-brushes  $11\frac{7}{8}$ d. for the same number; in all which a proportional drawback.

drawback is allowed. However, it is to be observed, that brushes are among the number of goods prohibited to be imported.

**BRUSSELS**, the capital of the province of Brabant, and of all the Austrian Netherlands. It is situated on the river Senne, and is the see of a bishop; W. long.  $4^{\circ} 6'$ , and N. lat.  $50^{\circ} 50'$ .

It is a strong fortified town, and agreeably situated, which, together with the viceroy's residence, occasions a great resort of nobility and gentry.

**BRUTE**, an animal guided mostly by mere instinct, and comprehends all animals, excepting mankind.

**BRUTON**, a market-town in Somersetshire, about ten miles south-east of Wells; W. long.  $2^{\circ} 35'$ , and N. lat.  $51^{\circ} 15'$ .

**BRYANSBRIDGE**, a town of Ireland, in the county of Clare, and province of Connaught, situated on the river Shannon, about eight miles north of Limerick.

**BRYGMUS**, among physicians, a grating noise made by the gnashing of teeth.

**BRYONIA**, in botany, a genus of the monœcia syngenesia class. The calix of the male has five teeth; the corolla is divided into five segments; and there are three filaments. The calix of the female is likewise toothed; the corolla has five divisions; the stylus is trifid; and the berry is roundish, and contains many seeds. There are six species of bryony, only one of which, *viz.* the alba, or white bryony, is a native of Britain. The root is a strong cathartic, and, applied externally, is said to be a powerful discutient.

*Black-BRYONY.* See **TAMUS**.

**BRYUM**, in botany, a genus of the cryptogamia musci class. The anthera is covered with an operculum; the calyptra is smooth. There are 41 species, most of them natives of Britain.

**BUBALIS**, in zoology, the trivial name of the buffalo, a species of the bos. See **BOS**.

**BUBBLE**, in philosophy, small drops or vesicles of any fluid filled with air, and either formed on its surface, by an addition of more of the fluid, as in raining, &c.; or in its substance, by an intestine motion of its component particles. Bubbles are dilatible or compressible, *i. e.* they take up more or less room, as the included air is more or less heated, or more or less pressed from without, and are round, because the included air acts equally from within, all around.

**BUBBLE**, in commerce, a cant term given to a kind of project for raising of money on imaginary grounds, much practised in France and England in the years 1719, 1720, and 1721.

The pretence of those schemes was the raising a capital for retrieving, setting on foot, or carrying on some promising and useful branch of trade, manufacture, machinery, or the like: To this end proposals were made out, shewing the advantages to be derived from the undertaking, and inviting persons to be engaged in it. The sum necessary to manage the affair, together with the profits expected from it, were divided into shares or subscriptions, to be purchased by any disposed to adventure therein.

Bubbles, by which the public have been tricked,

are of two kinds, *viz.* 1. Those which we may properly enough term trading-bubbles; and, 2. Stock or fund-bubbles. The former have been of various kinds; and the latter at different times, as in 1719 and 1720.

**BUBO**, in ornithology, the trivial name of a species of strix. See **STRIX**.

**BUBO**, or **BUBOE**, in surgery, a tumour which arises, with inflammation, only in certain or particular parts to which they are proper, as in the arm-pits and in the groins. See **MEDICINE**, and **SURGERY**.

**BUBON**, in botany, a genus of the pentandria digynia class. The fruit is oval, striated, and hairy. There are four species, and none of them natives of Britain.

**BUBONOCELE**, or **HERNIA INGUINALIS**, in surgery, a tumour in the inguen, formed by a prolapsus of the intestines, omentum, or both, through the processes of the peritonæum, and rings of the abdominal muscles. See **SURGERY**.

**BUBONIUM**, in botany, a synonyme of the inula. See **INULA**.

**BUCANEPHYLLON**, in botany, the name by which Plukenet calls the farracena. See **SARRACENA**.

**BUCARDIA**, or **BUCARDITÆ**, in natural history, a kind of figured stones, formed in the cavities of the larger cockles, and resembling, in some measure, a heart at cards.

**BUCARIZA**, a town of the kingdom of Hungary, in Croatia, upon the Adriatic sea, in a gulf that takes the same name.

**BUCCA ferrea**, in botany, a name given by Micheli to the ruppia of Linnæus. See **RUPPIA**.

**BUCCAL**, something belonging to the cheeks: Thus, the buccal glands, are those dispersed over the inner side of the cheeks.

**BUCCANEERS**, those who dry and smoke flesh or fish, after the manner of the Americans.

This name is particularly given to the French inhabitants of the island of St Domingo, whose whole employment is to hunt bulls, or wild boars, in order to sell the hides of the former, and the flesh of the latter.

The buccaneers are of two sorts: The buccaneers ox-hunters, or rather hunters of bulls and cows; and the buccaneers boar-hunters, who are simply called hunters; though it seems, that such a name be less proper to them than the former; since the latter smoke and dry the flesh of wild boars, which is properly called buccaneering, whereas the former prepare only the hides, which is done without buccaneering.

Buccaneering is a term taken from Buccan, the place where they smoke their flesh or fish, after the manner of the savages, on a grate or hurdle, made of Brasil wood, placed in the smoke, a considerable distance from the fire: This place is a hut, of about twenty five or thirty feet in circumference, all surrounded and covered with palmetto leaves.

**BUCCANEERS** also signify those famous adventurers of all the nations in Europe, who join together to make war against the Spaniards of America, cruising about in privateers, to take all the vessels and small craft they can meet with.

**BUCCARI**,

**BUCCARI**, a town of Istria upon the Adriatic sea, belonging to the house of Austria.

**BUCCARI**, or **BOUCHARI**, is also the name of a large province of Asiatic Tartary, situated between 78° and 90° E. lon. and 34° and 44° N. lat.

**BUCCELLARII**, an order of soldiery under the Greek emperors, appointed to guard and distribute the ammunition-bread; though authors are somewhat divided as to their office and quality. Among the Visigoths, buccellarius was a general name for a client or vassal who lived at the expence of his lord. Some give the denomination to parasites in the courts of princes, some make them the body-guards of emperors, and some fancy they were only such as emperors employed in putting persons to death privately.

**BUCCINA**, an ancient musical and military instrument. It is usually taken for a kind of trumpet; which opinion is confirmed by Festus, by his defining it a crooked horn, played on like a trumpet. Vegetius observes, that the buccina bent in a semicircle, in which respect it differed from the tuba or trumpet. It is very hard to distinguish it from the cornu or horn, unless it was something less, and not quite so crooked; yet it certainly was of a different species, because we never read of the cornu in use with the watch, but only the buccina. Besides, the sound of the buccina was sharper, and to be heard much farther, than either the cornu or the tuba. In scripture, the like instrument, used both in war and in the temple, was called rams-horns, kiren-jobel, and sopheroth hagijobelim.

**BUCCINUM** or **TRUMPET-SHELL**, a genus of shell-fish belonging to the order of vermes testaceæ. This animal is one of the snail kind. The shell is univalve, spiral, and gibbous. The aperture is oval, ending in a small strait canal. Linnæus enumerates about sixty species, most of which are found in the southern seas.

**BUCCO**, in ornithology, a genus belonging to the order of picæ. The beak is cultrated, turned inwards, compressed on the sides, and emarginated on each side at the apex; and there is a long slit below the eyes. The nostrils are covered with feathers. The feet have four toes, two before and two behind. There is but one species, viz. the capensis, which is of a reddish colour, with a yellow belt round the shoulders, and a black one round the breast. It is found at the Cape of Good-Hope.

**BUCCULA**, in antiquity, denotes the umbo, or most prominent part in the middle of a shield; so called, because usually fashioned like the mouth or face of a man or other animal.

**BUCENTAUR**, a galeas, or large galley of the doge of Venice, adorned with five pillars on both sides, and gilt over from the prow to the stern. This vessel is covered over head with a kind of tent, made of purple silk. In it the doge receives the great lords and persons of quality that go to Venice, accompanied with the ambassadors and counsellors of state, and all the senators seated on benches by him. The same vessel serves also in the magnificent ceremony of ascension-

day, on which the Duke of Venice throws a ring into the sea to espouse it, and to denote his dominion over the gulph of Venice.

**BUCENTAU** is also the name of a ship, as great and as magnificent as that of the Venetians, built by order of the elector of Bavaria, and launched on a lake, which is six leagues in length.

**BUCEROS**, in ornithology, a genus belonging to the order of picæ. The beak is convex, cultrated, very large, and ferrated outwards: The fore-head is naked, with a bony gibbosity. The nostrils are behind the base of the beak. The tongue is sharp and short. The feet are of the gressarii kind, i. e. the toes are distinct from each other. There are four species of the buceros, viz. 1. The bicornis, with a flat bony fore-head, and two horns before. The body is black, and about the size of a hen; but the breast, belly and thighs are white. There is a white spot on the wing; the tail is long, with ten black prime feathers, and the four outermost on each are white. The feet are greenish, with three toes before and one behind. It is a native of China, and called Calao by Willoughby and other authors. 2. The hydrocorax, or Indian crow of Ray, has a plain bony fore-head without any horns. The body is yellowish, and blackish below. It inhabits the Molucca isles. 3. The rhinoceros, has a crooked horn in the fore-head joined to the upper mandible. It is a native of India, and feeds upon carion. 4. The nasutus, has a smooth fore-head. It is about the size of a magpye, and is a native of Senegal.

**BUCH**, a town of Guienne, in France, which gives its name to a territory called *le Capitulat de Buch*.

**BUCHAN**, a country or district of Aberdeenshire, in Scotland: It gives the title of Earl to the noble and ancient family of Erskine.

**BUCHNERA**, in botany, a genus of the didynamia angiospermia class. The calix has five teeth; the corolla is divided into five equal heart-shaped segments; and the capsule is bilocular. There are three species, viz. The americana, a native of Canada and Virginia; the asiatica, a native of Ceylon and China; and the Africana, a native of Æthiopia.

**BUCHAW**, an imperial city of Swabia, in Germany, about twenty-five miles south-west of Ulm: E. long. 9° 40', and N. lat. 48° 5'.

**BUCHAREST**, a town of Wallachia, subject to the Turks: E. lon. 26° 30', and N. lat. 44° 20'.

**BUCHORN**, a city of Swabia, in Germany, situated on the east side of the lake of Constance, and about twelve miles east of the city of Constance: E. long. 9° 20', and N. lat. 47° 40'.

**BUCIOCHE**, in commerce, a sort of woolen cloth manufactured in Provence, which the french ships carry to Alexandria and Cairo.

**BUCK**, in zoology. See **CERVUS**.

**BUCK-BEAN**, in botany. See **MENYANTHES**.

**BUCK-THORN**, the English name of the rhamnus.

**BUCK-WHEAT**. See **POLYGONUM**.

**BUCKET**, a small portable vessel, to hold water, often made of leather for its lightness and easy use in cases of fire.

It is also the vessel let down into a well, or the sides of ships, to fetch up water.

**BUCKING**, the first operation in the whitening of linen yarn or cloth. See p. 564.

**BUCKINGHAM**, a borough-town of Buckinghamshire, about forty-six miles north-west of London: W. lon.  $1^{\circ}$ , and N. lat.  $51^{\circ} 50'$ .

It sends two members to parliament.

Buckinghamshire has Northamptonshire on the north; Bedford, Hertford, and Middlesex, on the east; Berkshire, from which it is divided by the river Thames, on the south; and Oxfordshire, on the west.

**BUCKLE**, a well known utensil, made of divers sorts of metals, as gold, silver, steel, brass, &c.

The fashion or form of buckles is various; but their use, in general, is to make fast certain parts of dress, as the shoes, garters, &c.

Buckles for girdles pay a duty of 3 s.  $10\frac{3}{8}$  d. the gross, or twelve dozen; whereof 1 s.  $4\frac{1}{2}$  d. is drawn back on exportation. Buckles for girts pay likewise a duty of 1 s.  $5\frac{1}{8}$  d. the gross; and both these pay somewhat more, if of brass. But it is to be observed, that all buckles are prohibited to be imported.

**BUCKLER**, a piece of defensive armour used by the ancients. It was worn on the left arm, and composed of wickers woven together, or wood of the lightest sort, but most commonly of hides, fortified with plates of brass or metal. The figure was sometimes round, sometimes oval, and sometimes almost square. Most of the bucklers were curiously adorned with all sorts of figures of birds and beasts, as eagles, lions; nor of these only, but of the gods, of the celestial bodies, and all the works of nature; which custom was derived from the heroic times, and from them communicated to the Grecians, Romans, and Barbarians.

*Votive* **BUCKLERS**. Those consecrated to the gods, and hung up in their temples, either in commemoration of some hero, or as a thanksgiving for a victory obtained over an enemy; whole bucklers, taken in war, were offered as a trophy.

**BUCKNHAM**, or **BUCKENHAM**, a market-town of Norfolk, about nine miles east of Thetford: E. long.  $1^{\circ} 10'$ , N. lat.  $52^{\circ} 30'$ .

**BUCKOR**, a province of the E. Indies, situated on the river Indus, having the province of Multan on the north, and Tasta on the south.

**BUCKRAM**, in commerce, a sort of coarse cloth made of hemp, gummed, calendered, and dyed several colours. It is put into those places of the lining of a garment, which one would have stiff, and to keep their forms. It is also used in the bodies of womens gowns; and it often serves to make wrappers to cover cloths, ferges, and such other merchandises, in order to preserve them and keep them from the dust, and their colours from fading. Buckrams are sold wholesale by the dozen of small pieces or remnants, each about four ells long, and broad according to the pieces from which they are cut. Sometimes they use new

pieces of linen-cloth to make buckrams, but most commonly old sheets and old pieces of fails.

Carrick buckrams pay a duty of  $5\frac{7}{8}$  d. the short piece; whereof  $5\frac{1}{8}$  d. is repaid on exporting it. East-country buckram pays 1 s.  $2\frac{1}{8}$  d. the roll or half-piece; whereof 1 s.  $\frac{3}{8}$  d. is drawn back. French buckram pays 1 l. 13 s.  $10\frac{1}{8}$  d. the dozen pieces; whereof 1 l. 00 s.  $1\frac{7}{8}$  d. is repaid. Fine German buckrams pay 2 s.  $4\frac{7}{8}$  d. the piece; whereof 2 s.  $1\frac{7}{8}$  d. is drawn back on exportation.

**BUCKSTALL**, a toil to take deer, which must not be kept by any body that has not a park of his own, under penalties.

**BUCOLIC**, in ancient poetry, a kind of poem relating to shepherds and country affairs, which, according to the most generally received opinion, took its rise in Sicily. Bucolics, says Vossius, have some conformity with comedy. Like it, they are pictures and imitations of ordinary life; with this difference, however, that comedy represents the manners of the inhabitants of cities, and bucolics the occupations of country people. Sometimes, continues he, this last poem is in form of a monologue, and sometimes of a dialogue. Sometimes there is action in it, and sometimes only narration; and sometimes it is composed both of action and narration. The hexameter verse is the most proper for bucolics in the Greek and Latin tongues. Moschus, Bion, Theocritus, and Virgil, are the most renowned of the ancient bucolic poets.

**BUD**, among gardeners, that part of a seed which first begins to sprout, or rather the leaves first put forth: These in some plants are two; in others, four; and in others again, six, or even more.

**Bud** is also used for the sprout from whence a branch arises.

**Bud**, in country-affairs, likewise denotes a weaned calf of the first year; so called, because the horns are then in the bud.

**BUDA**, the capital of lower Hungary, about 130 miles south-east of Vienna: It stands on the side of a hill, on the south-west side of the Danube, and is well fortified and defended by a castle, esteemed one of the strongest fortresses in Hungary: E. long.  $19^{\circ} 20'$ , N. lat.  $52^{\circ} 25'$ .

**BUDESDALE**, a market-town of Suffolk, about thirteen miles north-east of Bury: E. long.  $1^{\circ} 10'$ , and N. lat.  $52^{\circ} 25'$ .

**BUDDLE**, in mineralogy, a large square frame of boards, used in washing the tin ore. See **WASHING**.

**BUDDLEIA**, in botany, a genus of the tetrandria monogynia class. The calix and corolla are each divided into four parts; the stamina are inserted into the receptacle; the capsule has four cells, and contains many seeds. The species are two, *viz.* the occidentalis, and americana, both natives of America.

**BUDDLING**, the act of cleansing, or washing any ore. See **WASHING**.

**BUDGE-barrels**, among engineers, small barrels well hooped, with only one head; on the other end is nailed a piece of leather, to draw together upon strings like a purse. Their use is for carrying powder along with

- with a gun or mortar, being less dangerous, and easier carried, than whole barrels. They are likewise used upon a battery of mortars, for holding meal-powder.
- BUDINGEN**, the capital of a county of the same name in Germany, situated in the circle of the upper Rhine, about twenty miles north-east of Frankfort.
- BUDOVA**, a city of Dalmatia, situated on the gulf of Venice, in  $19^{\circ} 20'$  E. long. and  $42^{\circ} 15'$  N. lat.  
It is a bishop's see.
- BUDWEIS**, a town of Bohemia, situated on the river Muldaw, about sixty-five miles south of Prague: E. long.  $14^{\circ} 20'$ , N. lat.  $49^{\circ}$ .
- BUDZIAC TARTARY**, a country subject to the Turks, situated on the rivers Neister, Bog, and Nieper; having Poland and Ruffia, on the north; Little Tartary, on the east; the Black-sea, on the south; and Bessarabia, on the west.
- BUEN-AYRE**. See **BONAIRE**.
- BUENOS-AYRES**, one of the most considerable Spanish ports on the east coast of South America, situated on the southern shore of the river Plata, and about fifty leagues from its mouth; and yet here the river is full seven leagues broad: W. long.  $60^{\circ}$ , S. lat.  $36^{\circ}$ .  
It is a strong fortified town
- BUEN-RETIRO**, a palace near Madrid, belonging to the king of Spain.
- BUFF**, in commerce, a sort of leather prepared from the skin of the buffalo, which, dressed with oil, after the manner of shammy, makes what we call buff-skin. This makes a very considerable article in the French, English, and Dutch commerce at Constantinople, Smyrna, and all along the coast of Africa. The skins of elks, oxen, and other-like animals, when prepared after the same manner as that of the buffalo, are likewise called buffs.  
Of buff-skin, or buff-leather, are made a sort of coats for the horse or gens d'arms of France, bandoliers, belts, pouches and gloves.  
In France, there are several manufactories designed for the dressing of those sort of hides, particularly at Corbeil, near Paris; at Niort, at Lyons, at Rone, at Etanepus, at Cone.
- BUFFALO**, in zoology. See **Bos**.
- BUFFET** was anciently a little apartment, separated from the rest of the room by slender wooden columns, for the disposing of china, glass-ware, &c.  
It is now properly a large table in a dining-room, called also a side-board, for the plate, glasses, bottles, basons, &c. to be placed on, as well for the service of the table, as for magnificence. In houses of persons of distinction in France, the buffet is a detached room, decorated with pictures relative to the subject, with fountains, cisterns and vases. It is commonly faced with marble or bronze.
- BUFOON**, a droll or mimic who diverts the public by his pleasantries and follies.
- BUFO**, in zoology, the trivial name of a species of rana. See **RANA**.
- BUFONIA**, in botany, a genus of the diandria monogynia class. The calix is four-leaved; the petals are
- four; and the capsule is unilocular, and contains two seeds. There is but one species, viz. the tenuifolia or bastard chick-weed, a native of Britain.
- BUG**, a river, which, taking its rise in red Ruffia in Poland, runs northward to Bresse; and then, turning westward, falls into the Weisel, or Vistula, below Warsaw.
- BUG**, or **BUGG**, in zoology, the English name of a species of cimex. See **CIMEX**.
- BUGEN**, a town of Japan, the capital of the kingdom of that name, in the isle of Ximo.
- BUGEY**, a territory in France, being the fourth division of Bresse, in Burgundy, on the frontiers of Savoy.
- BUGGASINS**, in commerce, a name given to buckrams made of callico: these pay a duty, on importation, of 1s. 2 $\frac{1}{2}$ d. the half piece; whereof 1s. 1 $\frac{1}{2}$ d. is drawn back on exportation.
- BUGGERS**, in church-history, the same with bulgarians, a sect of heretics which, amongst other errors, held, that men ought to believe no scripture but the New Testament; that baptism was not necessary to infants; that husbands who conversed with their wives could not be saved; and that an oath was absolutely unlawful.
- BUGGERER**, a person who is guilty of the crime of buggery. See the next article.
- BUGGERY**, is defined by Sir Edward Coke to be a carnal copulation against nature, either by the confusion of species, that is to say, a man or woman with a brute beast; or sexes, as a man with a man, or man unnaturally with a woman. It is said this sin against God and nature was first brought into England by the Lombards; and anciently, according to some writers, it was punishable with burning; but others say, with burying alive. It is, by statute, felony without benefit of clergy, and is always excepted out of a general pardon.
- BUGIA**, a port-town of the kingdom of Algiers, in Africa, situated about sixty miles east of the city of Algiers; E. long.  $4^{\circ}$ , N. lat.  $35^{\circ} 30'$ .
- BUGIE**, a port-town of Egypt, situated on the western shore of the Red-sea, almost opposite to Ziden, the port-town to Mecca, and about 100 miles west of it; E. long.  $36^{\circ}$ , N. lat.  $22^{\circ}$ .
- BUGLE**, in botany. See **ADJUGA**.
- BUGLOSS**, in botany. See **ANCHUSA**.
- Viper's* **BUGLOSS**, in botany. See **ECHIU**.
- BUGULA**, **BUGLE**, in botany. See **ADJUGA**.
- BUHL**, a little fortress in Swabia, about six miles south-east of Stollhoffen, and nineteen north-east of Straßburg.
- BUILDING**, a fabric erected by art, either for devotion, for magnificence, or for conveniency.
- Regular* **BUILDING**, is that whose plan is square, the opposite sides equal, and the parts disposed with symmetry.
- Irregular* **BUILDING**, that whose plan is not contained with equal or parallel lines, either by the accident of situation, or the design of the builder, and whose parts are not relative to one another in the elevation.

*Insulated:*

*Insulated* BUILDING, that which is not contiguous to any other, but is encompassed with streets, open squares, or the like.

*Engaged* BUILDING, one surrounded with other buildings, having no front to any street or public place, nor any communication without, but by a common passage.

*Intervred or sunk* BUILDING, one whose area is below the surface of the place on which it stands, and of which the lowest courses of stone are concealed.

BUILDING is also used for the art of constructing and raising an edifice; in which sense it comprehends as well the expences, as the invention and execution of the design.

As for the materials of buildings, they are either stone, as marble, free-stone, brick for the walls, mortar, &c. or of wood, as fir, cypress, cedars for pillars of upright uses, oak for summers, beams, and crop-work, or for joining and connection. See ARCHITECTURE.

BUL, in the ancient Hebrew chronology, the eighth month of the ecclesiastical, and the second of the civil year; it has since been called Marthevan, and answers to our October.

BULAC, a town of Egypt, situated on the eastern shore of the river Nile, about two miles west of Grand Cairo, of which it is the port-town, and contains about four thousand families; E. long. 32°, and N. lat. 30°.

It is a place of great trade, as all the vessels going up and down the Nile make some stay here: it is also in this place that they cut the banks of the Nile every year, in order to fill their canals, and overflow the neighbouring grounds, without which the soil would produce neither grain nor herbage.

BULAFO, a musical instrument consisting of several pipes of wood, tied together with thongs of leather so as to form a small interstice between each pipe. It is used by the negroes of Guinea.

BULB, or BULBOUS ROOT, in the anatomy of plants, expresses a root of a round or roundish figure, and usually furnished with fibres at its base.

Bulbous roots are said to be solid, when composed of one uniform lump of matter; tunicated, when formed of multitudes of coats, surrounding one another; squamose, when composed of, or covered with lesser flakes; duplicate, when there are only two to each plant; and aggregate, when there is a congeries of such roots to each plant.

BULBOCASTANUM, in botany. See BUNIVM.

BULBOCODIVM, in botany, a genus of the hexandria monogynia class. The corolla is shaped like a tunnel, and consists of five petals; the claws of the petals are narrow. There is but one species, viz. the vernum, a native of Spain.

BULBOSE. See BULB.

BULEUTÆ, in Grecian antiquity, were magistrates answering to the decuriones among the Romans. See DECURIO.

BULGAR, the capital of the province of Bulgar, in

Russia, situated on the river Wolga; E. long. 51°, and N. lat. 54°.

BULGARIA, a province of Turkey in Europe, bounded by the river Danube, which divides it from Wallachia and Moldavia on the north, by the Black Sea on the east, by Romania on the south, and by Servia on the west. Its chief city is Nicopolis.

BULGARIAN language, the same with the Sclavonic.

BULIMY, a disease in which the patient is affected with an insatiable and perpetual desire of eating; and, unless he is indulged, he often falls into fainting fits. It is also called *fames canina*, canine appetite.

BULITHUS, a stone found either in the gall-bladder, or in the kidneys and bladder of an ox. See BOS.

BULK of a ship, the whole content in the hold for the stowage of goods.

BULK-HEADS are partitions made athwart the ship with boards, by which one part is divided from the other; as the great cabin, gun-room, bread-room, and several other divisions. The bulk-head afore is the partition between the fore-castle and gratings in the head.

BULL, in zoology. See BOS.

BULL, in astronomy. See ASTRONOMY, p. 486, 487.

BULL'S-EYE, among seamen, a small, obscure, sublime cloud, ruddy in the middle, that sometimes appears to mariners, and is the immediate forerunner of a great storm at sea.

BULL-FINCH, in ornithology. See LOXIA.

BULL-FROG, in zoology, See RANA.

BULL-HEAD, in ichthyology. See COTTUS.

BULL, among ecclesiastics, a written letter, dispatched, by order of the pope, from the Roman chancery, and sealed with lead, being written on parchment, by which it is partly distinguished from a brief. See the article BRIEF.

It is a kind of apostolical rescript, or edict, and is chiefly in use in matters of justice or grace. If the former be the intention of the bull, the lead is hung by a hempen cord; if the latter, by a silken thread. It is this pendent lead, or seal, which is, properly speaking, the bull, and which is impressed, on one side, with the heads of St. Peter and St. Paul, and on the other with the name of the pope and the year of his pontificate. The bull is written in an old, round, gothic letter, and is divided into five parts, the narrative of the fact, the conception, the clause, the date, and the salutation, in which the pope styles himself *servus servorum*, i. e. the servant of servants.

These instruments, besides the lead hanging to them, have a cross, with some text of scripture, or religious motto, about it. Bulls are granted for the consecration of bishops, the promotion to benefices, and the celebration of jubilees, &c.

BULL in *cena Domini*, a particular bull read every year, on the day of the Lord's supper, or Maundy Thursday, in the pope's presence, containing excommunications and anathemas against heretics, and all who disturb or oppose the jurisdiction of the holy see.

After

After the reading of the bull, the pope throws a burning torch into the public place, to denote the thunder of this anathema.

**Golden BULL**, an edict, or imperial constitution, made by the emperor Charles IV. reputed to be the magna charta, or the fundamental law of the German empire.

It is called golden, because it has a golden seal, in the form of a pope's bull, tied with yellow and red cords of silk: upon one side is the emperor represented sitting on his throne, and on the other the capitol of Rome. It is also called Caroline, on Charles IV's account. Till the publication of the golden bull, the form and ceremony of the election of an emperor were dubious and undetermined, and the number of the electors not fixed. This solemn edict regulated the functions, rights, privileges, and pre-eminences of the electors. The original, which is in Latin, on vellum, is preserved at Frankfort: this ordonnance, containing thirty articles, or chapters, was approved of by all the princes of the empire, and remain still in force.

**BULLA**, in zoology, a genus belonging to the order of vermes testaceæ. It is an animal of the snail-kind: The shell consists of one valve, convoluted, and without any prickles; the aperture is narrowish, oblong, longitudinal, and entire at the base; the columella is smooth and oblique. There are twenty-three species, most of them natives of the Asiatic and Atlantic oceans.

**BULLÆ**, in Roman antiquity, ornaments at first given only to the sons of noblemen; though afterwards they became of more common use. This ornament was first given by Tarquinius with the prætexta to his son, who had, with his own hand, at fourteen years of age, killed an enemy. Thus we find the bulla was a sign of triumph. Macrobius relates, that the children of freed men were allowed to wear the prætexta, and, instead of the golden bulla, a leathern one, about their necks: Those bullæ were made hollow within to inclose amulets against envy, &c. When the youth arrived at fifteen years of age, they hung up their bullæ about the necks of their gods lares. We are farther informed, that the bullæ were not only hung about the necks of young men, but of horses also.

**BULLEN**, a term used by country people for hemp-stalks peeled.

**BULLET**, an iron or leaden ball, or shot, wherewith fire-arms are loaded. See **BALL**.

**BULLINGBROKE**, in geography. See **BOLINGBROOK**.

**BULLION**, uncoined gold or silver in the mass.

Those metals are called so, either when smelted from the native ore, and not perfectly refined; or when they are perfectly refined, but melted down in bars or ingots, or in any unwrought body, of any degree of fineness.

When gold and silver are in their purity, they are so soft and flexible, that they cannot well be brought into any fashion for use, without being first reduced and hardened with an alloy of some other baser metal.

To prevent these abuses, which some might be

tempted to commit in the making of such alloys, the legislators of civilized countries have ordained, that there shall be no more than a certain proportion of a baser metal to a particular quantity of pure gold or silver, in order to make them of the fineness of what is called the standard gold or silver of such a country.

According to the laws of England, all sorts of wrought plate in general, ought to be made to the legal standard; and the price of our standard gold and silver is the common rule whereby to set a value on their bullion, whether the same be in ingots, bars, dust, or in foreign specie: whence it is easy to conceive that the value of bullion cannot be exactly known, without being first assayed, that the exact quantity of pure metal therein contained may be determined, and consequently whether it be above or below the standard.

Silver and gold, whether coined or uncoined, (tho' used for a common measure of other things), are no less a commodity, than wine, tobacco, or cloth; and may, in many cases, be exported as much to the national advantage as any other commodity.

**BULLOCK**, the same with an ox, or gelded bull. See **Bos**.

**BULLY-TREE**, in botany. See **CHRYSOPHYLLUM**.

**BULTEL**, a term used to denote the refuse of meal after dressing, or the cloth wherein it is dressed, otherwise called bulter-cloth.

**BULWARK**, in the ancient fortification. See **RAMPART**.

**BUMICILLI**, a religious sect of Mahometans in Egypt and Barbary, who pretend to fight with devils, and commonly appear in a fright and covered with wounds and bruises. About the full moon they counterfeit a combat in the presence of all the people, which lasts for two or three hours, and is performed with assagais, or javelins, till they fall down quite spent; in a little time, however, they recover their spirits, get up, and walk away.

**BUNGAY**, a market-town of Suffolk, situated on the river Wavenny, about thirty-two miles north-east of Bury: E. lon. 1° 35', and N. lat. 52° 35'.

**BUNGO**, or **BONGO**. See **BONGO**.

**BUNIAS**, in botany, a genus of the tetradynamia siliquosa class. The pod is deciduous, quadrangular, and the angles are unequal and terminate in sharp points. There are four species, only one of which, viz. the cakile, or sea-rocket, is a native of Britain.

**BUNDLE**, a collection of things wrapped up together. Of baste-ropes, harness-plates, and glover's knives, ten make a bundle; of hamburg yarn, twenty skeans; of basket-rods, three feet about the band.

**BUNIAM**, in botany, a genus of the pentandria digynia class. The corolla is uniform; the umbella is thick; and the fruit is oval. There is but one species, viz. the bulbocastanum, earth-nut, kipper-nut, pig-nut, or hawk-nut, a native of Britain.

**BUNK**, or **BUNKEN**, in the materia medica. See **LEUCACANTHA**.

**BUNT of a sail**, the middle part of it, formed designedly into a bag or cavity, that the sail may gather

more wind. It is used mostly in top-sails, because courses are generally cut square, or with but small allowance for bunt or compass. The bunt holds much leeward wind, that is, it hangs much to leeward.

**BUNT-LINES** are small lines made fast to the bottom of the sails, in the middle part of the bolt-rope, to a cringle, and so are reeved through a small block, seized to the yard. Their use is to trice up the bunt of the sail, for the better furling it up.

**BUNTING**, in ornithology, the English name of a species of fringilla. See **FRINGILLA**.

**BUNTINGFORD**, a market-town of Hertfordshire, about twelve miles north of Hertford: W. long. 5', and N. lat. 51° 55'.

**BUNTZLAU**, or **BUNTZEL**, the name of two towns in Germany: the old town is situated on the river Elbe, and new town, which is become the most considerable, upon the Gizare, eight leagues from Lignitz, in 16° 26' E. long. and 51° 12' N. latitude. There is likewise a town of that name in Silesia.

**BUONO**, as **TEMPO-BUONO**, in music, signifies a certain time or part of the measure, more proper for certain things than any other, as to end a cadence or pause, to place a long syllable or syncoped dissonance, concord, &c. In common time of four times to a bar, the first and third is one buono tempo, as the second and last are called *tempo di caniva*.

**BUOY**, at sea, a short piece of wood, or a close-hooped barrel, fastened so as to float directly over the anchor, that the men, who go in the boat to weigh the anchor, may know where it lies.

**BUOY** is also a piece of wood, or cork, sometimes an empty cask, well closed, swimming on the surface of the water, and fastened, by a chain or cord, to a large stone, piece of broken cannon, or the like, serving to mark the dangerous places near a coast, as rocks, shoals, wrecks of vessels, anchors, &c.

There are sometimes, instead of buoys, pieces of wood placed in form of masts, in conspicuous places; and sometimes large trees are planted in a particular manner, in number two at least, to be taken in a right line, the one hiding the other, so as the two may appear to the eye no more than one.

*Stream the Buoy* is to let the anchor fall while the ship has way.

*To buoy up the cable* is to fasten some pieces of wood, barrels, &c. to the cable, near the anchor, that the cable may not touch the ground, in case it be foul or rocky, lest it should be fretted and cut off.

**BUOYANT**, something which, by its aptness to float, bears up other more ponderous and weighty things. See **BUOY**.

**BUPHAGA**, in ornithology, a genus belonging to the order of picæ. The beak is straight and quadrangular; the mandibles are gibbous, entire, and the gibbosity is greater on the outside. The feet are of the ambulatory kind. The body is greyish above, and of a dirty yellow below; the tail is shaped like a wedge. It is a native of Senegal; and frequently perches upon oxen, and picks out the worms from their backs.

**BUPHTHALMUM**, a genus of the syngenesia polyga-

mia superflua class. The receptacle is paleaceous; the margin of the pappus is obsolete; the sides of the seeds are marginated; and the stigmata of the hermaphrodite floccules are undivided. The species are ten, none of which are natives of Britain.

**BUPLEURUM**, in botany, a genus of the pentandria digynia class. The involucre of the umbels is large and five-leaved; the fruit is striated, compressed, and roundish. The species are seventeen, only two of which are natives of Britain, viz. the rotundifolium, or thorum-wax; and the tenuissimum, or the least hare's-ear.

**BUPRESTIS**, in zoology, a genus of insects belonging to the order of coleoptera. The feelers are like bristles, and about the length of the breast; the lead is half retracted into the thorax. There are twenty-seven species of this insect, most of them natives of the Indies.

**BUQUOI**, a town of Artois, in the French Netherlands, situated on the confines of Picardy: E. long. 2° 40', and N. lat. 50° 12'.

**BUR**, a broad ring of iron, behind the plate made for the hand on the spears used formerly in tilting, which bur was brought to rest, when the tilter charged his spear.

**BURBAS**, in commerce, a small coin at Algiers, with the arms of the dey struck on both sides: it is worth half an asper.

**BURCHAUSEN**, a town of Germany, in the Lower Bavaria, situated on the river Saltz: E. long. 13° 25', and N. lat. 48° 5'.

**BURDEN**, or **BURDON**, in music, the drone or bass, and the pipe or string which plays it: Hence that part of a song, that is repeated at the end of every stanza, is called the burden of it.

A chord which is to be divided, to perform the intervals of music, when open and undivided, is also called the burden.

**BURDEN of a ship** is its contents, or number of tons it will carry. The burden of a ship may be determined thus: multiply the length of the keel, taken within board, by the breadth of the ship, within board, taken from the midship-beam, from plank to plank, and multiply the product by the depth of the hold, taken from the plank below the keelson, to the under part of the upper deck plank, and divide the last product by 94, then the quotient is the content of the tonnage required. See **FREIGHT**.

**BURDO**, that kind of mule produced between a horse and a she-ass. See **MULE**.

**BURDOCK**, in botany, the English name of the xanthium. See **XANTHIUM**.

**BURDUGNO**, a town of the Morea, situated on the river Vasilipotomo, near Mistra.

**BUREN**, a town of Dutch Guelderland, about sixteen miles west of Nimeguen: E. long. 5° 20', and N. lat. 52°.

**BUREN** is also the name of a town in Westphalia in Germany, about five miles south of the city of Paderborn: E. long. 8° 25', and N. lat. 51° 35'.

**BURFORD**, a market-town of Oxfordshire, about fifteen



teen miles west of Oxford: W. long.  $1^{\circ} 40'$ , N. lat.  $51^{\circ} 40'$ .

It gives the title of earl to the noble family of Beauclerc.

**BURG**, a town of Zutphen, in the Dutch Netherlands, situated upon the Old Iffel, about eighteen miles east of Nimeguen: E. long.  $6^{\circ} 10'$ , and N. lat.  $52^{\circ}$ .

**BURGA**, a cape of Algiers in Africa, running out into the Mediterranean sea.

**BURGAGE**, an ancient tenure in boroughs, whereby the inhabitants, by custom, hold their lands, &c. of the king, or other superior lord of the borough, at a certain yearly rent: Also a dwelling-house in a borough, was anciently called a burgage.

**BURGEON**, a term used by gardeners in the same sense with bud. See **BUD**.

**BURGESS**, an inhabitant of a borough, or one who possesses a tenement therein.

In other countries, burghs and citizen are confounded together; but with us they are distinguished: The word is also applied to the magistrates of some towns.

Burgess is now ordinarily used for the representative of a borough-town in parliament.

**BURGGRAVE** properly denotes the hereditary governor of a castle or fortified town, chiefly in Germany.

**BURGH**, See **BOROUGH**.

**BURGH-bote** signifies a contribution towards the building or repairing of castles, or walls, for the defence of a borough, or city.

**BURGH-breche** is properly the breaking open a burgh, house, inclosure, &c. and in the laws of Canute, cap. lv. signifies a fine imposed upon a community of a town for a breach of the peace. According to Rastallus, burgh-breche is, to be quit of trespasses committed against the peace, in city or borough.

**BURGHMESTERS**. See **BURGMASER**.

**BURGHMASTER**, among miners. See **BARMASER**.

**BURGHMOTE**, the court of a borough.

**BURGLARY**, a felonious breaking and entering into the dwelling-house of another person in the night-time, with an intent to commit some felony, whether the same be executed, or not.

The like offence committed by day, is called house-breaking.

Burglary is an offence excluded the benefit of clergy, and may be committed by taking away goods from a dwelling-house, any person being therein; or breaking any shop, warehouse, &c. though in the day-time, and taking goods from thence of five shillings value, if no person be therein.

**BURGLES**, a town of Transilvania, about thirty miles north of Clausenburg, subject to the house of Austria: E. long.  $22^{\circ} 40'$ , and N. lat.  $47^{\circ} 40'$ .

**BURGMASER**, the chief magistrate of the great towns in Flanders, Holland, and Germany. The power and jurisdiction of the burgomaster is not the same in all places, every town having its particular customs and regulations: At Amsterdam there are four chosen by the voices of all those people in the senate,

who have either been burgomasters or echevins. Their authority resembles that of our lord-mayor and aldermen; they dispose of all under-offices that fall in their time, keep the key of the bank, and enjoy a salary but of five hundred guilders, all feasts, public entertainments, &c. being defrayed out of the common treasury.

**BURGOO**, a dish frequent at sea, being made of oat-meal, or greets, boiled in water till they burst, and then some butter added.

**BURGOS**, the capital of Old Castile in Spain, about one hundred and ten miles north of Madrid: W. long.  $4^{\circ} 5'$ , and N. lat.  $42^{\circ} 30'$ .

**BURGOW**, a town of Swabia in Germany, about twenty miles west of Augsburg: E. long.  $10^{\circ} 20'$ , N. lat.  $48^{\circ} 30'$ .

**BURGUNDY**, or **BURGOGNE**, a province or government in France, having Champaign on the north, and Dauphine on the south.

**BURIAL**, the interment of a deceased person.

The rites of burial are looked upon in all countries, and at all times, as a debt so sacred, that such as neglected to discharge it were thought accursed: Hence the Romans called them *justa*, and the Greeks [*nomima*, *dikaia*, *bosia*,] &c. words implying the inviolable obligations which nature has laid upon the living to take care of the obsequies of the dead. Nor are we to wonder, that the ancient Greeks and Romans were extremely solicitous about the interment of their deceased friends, since they were strongly persuaded, that their souls could not be admitted into the Elysian fields till their bodies were committed to the earth; and if it happened that they never obtained the rites of burial, they were excluded from the happy mansions for the term of an hundred years. For this reason it was considered as a duty incumbent upon all travellers who should meet with a dead body in their way, to cast dust or mould upon it three times, and of these three handfuls, one at least was cast upon the head. The ancients likewise considered it as a great misfortune if they were not laid in the sepulchres of their fathers; for which reason, such as died in foreign countries had usually their ashes brought home, and interred with those of their ancestors. But notwithstanding their great care in the burial of the dead, there were some persons whom they thought unworthy of that last office, and to whom therefore they refused it: Such were, 1. Public or private enemies. 2. Such as betrayed, or conspired against their country. 3. Tyrants, who were always looked upon as enemies to their country. 4. Villains guilty of sacrilege. 5. Such as died in debt, whose bodies belonged to their creditors. And, 6. Some particular offenders, who suffered capital punishment.

Of those who were allowed the rites of burial, some were distinguished by particular circumstances of disgrace attending their interment: Thus persons killed by lightning were buried apart by themselves, being thought odious to the gods; those who wasted their patrimony, forfeited the right of being buried in the sepulchres of their fathers; and those who were guilty of

of

of self-murder were privately deposited in the ground, without the accustomed solemnities. Among the Jews, the privilege of burial was denied only to self-murderers, who were thrown out to rot upon the ground. In the Christian church, though good men always desired the privilege of interment, yet they were not, like the heathens, so concerned for their bodies, as to think it any detriment to them, if either the barbarity of an enemy, or some other accident, deprived them of this privilege. The primitive Christian church denied the more solemn rites of burial only to unbaptized persons, self-murderers, and excommunicated persons who continued obdurate and impenitent, in a manifest contempt of the church's censures.

The place of burial among the Jews was never particularly determined. We find they had graves in the town and country, upon the highways, in gardens, and upon mountains. Among the Greeks, the temples were made repositories for the dead in the primitive ages; yet the general custom in latter ages, with them, as well as with the Romans and other heathen nations, was to bury their dead without their cities, and chiefly by the highways. Among the primitive Christians, burying in cities was not allowed for the first three hundred years, nor in churches for many ages after, the dead bodies being first deposited in the atrium or church-yard, and porches and porticos of the church: hereditary burying-places were forbidden till the 12th century. As to the time of burial, with all the ceremonies accompanying it, see the article FUNERAL-RITES.

**BURICK**, a town of the duchy of Cleves, in the circle of Westphalia in Germany, situated on the river Rhine, about twenty miles south of Cleves: E. long.  $6^{\circ} 5'$ , N. lat.  $51^{\circ} 35'$ .

**BURLESQUE**, a species of composition, which, tho' a great engine of ridicule, is not confined to that subject; for it is clearly distinguishable into burlesque that excites laughter merely, and burlesque that excites derision or ridicule. A grave subject, in which there is no impropriety, may be brought down by a certain colouring so as to be risible, as in Virgil Travestie; the author first laughs at every turn, in order to make his readers laugh. The Lutrin is a burlesque poem of the other sort, laying hold of a low and trifling incident to expose the luxury, indolence, and contentious spirit of a set of monks. Boileau, the author, turns the subject into ridicule by dressing it in the heroic style; and affecting to consider it as of the utmost dignity and importance. Though ridicule is the poet's aim, he always carries a grave face, and never once bewrays a smile. The opposition between the subject and the manner of handling it, is what produces the ridicule; and therefore, in a composition of this kind, no image professedly ludicrous ought to have quarter, because such images destroy the contrast.

Though the burlesque that aims at ridicule, produces its effects by elevating the style far above the subject, yet the poet ought to confine himself to such images as are lively, and readily apprehended. A strained elevation, soaring above the ordinary reach of fan-

cy, makes not a pleasant impression. The mind is soon disgusted by being kept long on the stretch. Machinery may be employed in a burlesque poem, such as the Lutrin, the Dispensary, or Hudibras, with more success and propriety than in any other species of poetry. For burlesque poems, though they assume the air of history, give entertainment chiefly by their pleasant and ludicrous pictures: It is not the aim of such a poem to raise sympathy; and for that reason, a strict imitation of nature is not necessary. And hence, the more extravagant the machinery in a ludicrous poem, the more entertainment it affords.

**BURLINGTON**, a sea-port town in the East Riding of Yorkshire, situated on the German ocean, about thirty-seven miles north-east of York: E. long.  $10'$ , and N. lat.  $54^{\circ} 15'$ .

It gives the title of earl to a branch of the noble family of Boyle.

**New BURLINGTON**, the capital of New-Jersey, in North America; situated in an island of Delaware river, about twenty miles north of Philadelphia: W. long.  $74^{\circ}$ , and N. lat.  $40^{\circ} 40'$ .

**BURMANNIA**, in botany, a genus of the hexandria monogynia class. The calix is shaped like a prism, coloured and divided into three segments, with membranaceous angles; the petals are three; the capsule is three-celled; and the seeds are very small. There are only two species, none of them natives of Britain.

**BURN**, in medicine and surgery, an injury received in any part of the body by fire. See MEDICINE, and SURGERY.

**BURNET**, in botany. See POTERIUM, and SANGUISORBA.

**BURNHAM**, a market-town of Norfolk, about 25 miles north-west of Norwich: E. long.  $50'$ , and N. lat.  $53^{\circ}$ .

**BURNING**, the action of fire on some pabulum, or fuel, by which the minute parts thereof are put into a violent motion, and some of them assuming the nature of fire themselves, fly off *in orbem*, while the rest are dissipated in form of vapour, or reduced to ashes. See FIRE.

**BURNING**, or **BRENNING**, in our old customs, denotes an infectious disease, got in the stews by conversing with lewd women, and supposed to be the same with what we now call the venereal disease.

In a manuscript of the vocation of John Bale to the bishopric of Ossory, written by himself, he speaks of Dr. Hugh Weston, who was dean of Windsor, in 1556, but deprived by cardinal Pole for adultery, thus: "At this day is lecherous Weston, who is more practised in the arts of breech-burning, than all the whores of the stews. He not long ago bred a beggar of St. Botolph's parish." See STEWS.

**BURNING**, in antiquity, a way of disposing of the dead, much practised by the ancient Greeks and Romans, and still retained by several nations in both the East and West Indies.

Eustathius assigns two reasons why burning came to be of so general use in Greece; the first is, because bodies were thought to be unclean after the soul's departure,

parture, and therefore were purified with fire. The second reason is, that the soul, being separated from the gross and unactive matter, might be at liberty to take its flight into heaven. The body was rarely burnt without company, for besides the various animals they threw upon the pile, we seldom find a man of quality consumed without a number of slaves and captives, which, in barbarous times, they used to murder for that purpose: and in some parts of the East Indies it is customary, at this day, for wives to throw themselves into the funeral pile with their deceased husbands. At the funerals of emperors, generals, &c. who had their arms burnt with them, the soldiers made procession three times round the funeral pile with shouts and trumpets, to express their respect to the dead. During the burning also, the dead person's friends stood by, called on the deceased, and poured out libations of wine, with which, when the pile was burnt down, they extinguished the remains of the fire; and having collected the bones of the deceased, washed them with wine, and anointed them with oil. When the bones were discovered, they gathered the ashes that lay close to them, and both were repositied in urns, either of wood, stone, earth, silver, or gold, according to the quality of the deceased. See URN.

**BURNING**, among surgeons. See CAUTERIZATION.

Burning is much practised by the people of the East Indies, particularly those of Japan, who use the moxa for this purpose. See MOXA.

**BURNING-glass**, a convex or concave glass, commonly spherical, which being exposed directly to the sun, collects all the rays falling thereon into a very small space, called the focus; where wood, or any other combustible matter being put, will be set on fire. See OPTICS.

**BURNING-mountains**. See VOLCANO.

**BURNING of colours**, among painters. There are several colours that require burning; as first, lamp-black; which is a colour of so greasy a nature, that, except it is burnt, it will require a long time to dry.

The method of burning, or rather drying, lamp-black, is as follows: Put it into a crucible over a clear fire, letting it remain till it be red hot, or so near it that there is no manner of smoke arises from it.

Secondly, Umber, which if it be intended for colour for a horse, or to be a shadow for gold, then burning fits it for both these purposes.

In order to burn umber, you must put it into the naked fire, in large lumps, and not take it out till it is thoroughly red hot; if you have a mind to be more curious, put it into a crucible, and keep it over the fire till it be red hot.

Ivory also must be burnt to make black, thus: fill two crucibles with shavings of ivory, then clap their two mouths together, and bind them fast with an iron wire, and lute the joints close with clay, salt, and horse-dung, well beaten together; then set it over the fire, covering it all over with coals: let it remain in the fire, till you are sure that the matter inclosed is thoroughly red hot: then take it out of the fire; but do not open the crucibles till they are perfectly

cold; for were they opened while hot, the matter would turn to ashes; and so it will be, if the joints are not luted close.

**BURNISHER**, a round, polished piece of steel, serving to smooth and give a lustre to metals.

Of these there are different kinds of different figures, straight, crooked, &c. Half burnishers are used to solder silver, as well as to give a lustre. See SOLDERING.

**BURNISHING**, the art of smoothing or polishing a metalline body, by a brisk rubbing of it with a burnisher.

Book-binders burnish the edges of their books, by rubbing them with a dog's tooth. Gold and silver are burnished, by rubbing them with a wolf's tooth, or by the bloody stone, or by tripoli, a piece of white wood, emery, and the like. Deer are said to burnish their heads, by rubbing off a downy white skin from their horns, against a tree.

**BURNLEY**, a market-town of Lancashire, about 27 miles south-east of Lancaster: W. long.  $2^{\circ} 5'$ , and N. lat.  $53^{\circ} 40'$ .

**BURR**, the round knob of a horn next a deer's head.

**BURRE**, **BOUREE**, or **BORRE**, a kind of dance composed of three steps joined together in two motions, begun with a crotchet rising. The first couplet contains twice four measures, the second twice eight. It consists of a balance and coupee.

**BURREGREG**, a considerable river of the kingdom of Fez, in Africa; which taking its rise in the Atlas mountains, falls into the ocean not far from the straits of Gibraltar.

**BURR-PUMP**, or **BILDGE-PUMP**, differs from the common pump, in having a staff 6, 7, or 8 feet long, with a bar of wood, whereto the leather is nailed, and this serves instead of a box. So two men, standing over the pump, thrust down this staff, to the middle whereof is fastened a rope, for 6, 8, or 10 to hale by, thus pulling it up and down.

**BURROCK**, a small wier or dam, where wheels are laid in a river, for the taking of fish.

**BURROW**, or **BOROUGH**. See BOROUGH.

**BURROWS**, holes in a warren, which serve as a covert for hares, rabbits, &c.

**BURSA**, or **PRUSA**, in geography, the capital of Bithinia, in Asia Minor, situated in a fine fruitful plain, at the foot of mount Olympus, about an hundred miles south of Constantinople: E. long.  $29^{\circ}$ , and N. lat.  $40^{\circ} 30'$ .

**BURSA-pastoris**, in botany. See THLASPI.

**BURSAR**, in a general sense, signifies a treasurer or purse-keeper, especially in a monastery.

**BURSE**, in a commercial sense, a place for merchants to meet in, and negotiate their business publicly, with us called exchange. See EXCHANGE.

**BURSTEN**, denotes a person who has a rupture. See RUPTURE.

**BURTON**, in geography, the name of two market-towns, the one in Staffordshire, and the other in Lincolnshire; the former being situated about 18 miles east of Stafford, in  $1^{\circ} 36'$  W. long. and  $52^{\circ} 40'$

N. lat. and the latter, thirty miles north of Lincoln, in 30° W. long. and 53° 40' N. lat.

**BURTON** is also the name of a market-town in Westmoreland, about thirty miles south-west of Appleby: W. long. 2° 35', N. lat. 54° 10'.

**BURTON**, in the sea-language, a small tackle consisting of two single blocks, and may be made fast any where at pleasure, for hoisting small things in and out; and will purchase more than a single tackle with two blocks.

**BURY**, in geography, a market-town of Lancashire, about 30 miles south-east of Lancaster: W. long. 2° 20', N. lat. 53° 36'.

**BURY St EDMUNDS**, or **St EDMUND'S BURY**, the county-town of Suffolk, about twelve miles east of Newmarket, and seventy north-east of London: E. long. 45', N. lat. 52° 20'.

**BURY** is also a term sometimes used for the hole or den of some animal under ground, more usually called burrow.

Thus we say, the bury of a mole, rabbit, &c.

**BUSH**, a term used for several shrubs of the same kind growing close together: thus we say, a furze-bush, bramble-bush, &c.

**BUSH** is sometimes used, in a more general sense, for any assemblage of thick branches interwoven and mixed together.

**Burning-Bush**, that bush wherein the Lord appeared to Moses at the foot of mount Horeb, as he was feeding his father-in-law's flocks.

As to the person that appeared in the bush, the text says, "That the angel of the Lord appeared unto him in a flame of fire, out of the middle of the bush:" but whether it was a created angel, speaking in the person of God, or God himself, or (as the most received opinion is) Christ the Son of God, has been matter of some controversy among the learned. Those who suppose it no more than an angel, seem to imply that it would be a diminution of the majesty of God, to appear upon every occasion, especially when he has such a number of celestial ministers, who may do the business as well. But considering that God is present every where, the notification of his presence by some outward sign in one determinate place, (which is all we mean by his appearance), is in our conception less laborious (if any thing laborious could be conceived of God) than a delegation of angels upon every turn from heaven, and seems in the main to illustrate rather than debase the glory of his nature and existence. But however this be, it is plain that the angel here spoken of was no created being, from the whole context, and especially from his saying, "I am the Lord God, the Jehovah," &c. since this is not the language of angels, who are always known to express themselves in such humble terms as these, "I am sent from God; I am thy fellow-servant," &c. It is a vain pretence to say, that an angel, as God's ambassador, may speak in God's name and person; for what ambassador of any prince ever yet said, "I am the king." Since therefore no angel, without the guilt

of blasphemy, could assume these titles; and since neither God the Father, nor the Holy Ghost, are ever called by the name of angel, *i. e.* a messenger, or person sent, whereas God the Son is called by the prophet Malachi, (chap. iii. 1.), "The angel of the covenant;" it hence seems to follow, that this angel of the Lord was God the Son, who might very properly be called an angel, because in the fulness of time he was sent into the world in our flesh, as a messenger from God, and might therefore make these his temporary apparitions, prefaces and forerunners, as it were, of his more solemn mission.

The Mahometans believe, that one of Moses's shoes, put off by him as he drew near the burning-bush, was placed in the ark of the covenant, in order to preserve the memory of this miracle.

**BUSHEL**, a measure of capacity for dry things, as grain, fruits, dry pulse, &c. containing four pecks, or eight gallons, or one-eighth of a quarter.

A bushel, by 12 Henry VII. c. 5. is to contain eight gallons of wheat; the gallon eight pounds of troy-weight; the ounce twenty sterlings, and the sterling thirty-two grains, or corns of wheat growing in the middle of the ear.

At Paris, the bushel is divided into two half bushels; the half bushel into two quarts; the quart into two half quarts; the half quart into two litrons; and the litron into two half litrons. By a sentence of the provost of the merchants of Paris, the bushel is to be eight inches two lines and a half high, and ten inches in diameter; the quart four inches nine lines high, and six inches nine lines wide; the half quart four inches three lines high, and five inches diameter; the litron three inches and a half high, and three inches ten lines in diameter. Three bushels make a minot; six, a mine; twelve, a septier; and an hundred and forty-four, a muid. In other parts of France the bushel varies.

Oats are measured in a double proportion to other grains, so that twenty-four bushels of oats make a septier, and 288 a muid. The bushel of oats is divided into four picotins, the picotin into two half quarts, or four litrons. For salt, four bushels make one minot, and six a septier; for coals, eight bushels make one minot, sixteen a mine, and 320 a muid; for lime, three bushels make a minot, and forty-eight minots a muid.

**BUSKIN**, a kind of shoe, somewhat in manner of a boot, and adapted to either foot, and worn by either sex.

This part of dress, covering both the foot and mid-leg, was tied underneath the knee; it was very rich and fine, and principally used on the stage by actors in tragedy. It was of a quadrangular form, and the sole was so thick, as that, by means thereof, men of the ordinary stature might be raised to the pitch and elevation of the heroes they personated. The colour was generally purple on the stage: herein it was distinguished from the sock, worn in comedy, that being only a low common shoe. The buskin seems to have

have been worn, not only by actors, but by girls, to raise their height; travellers and hunters also made use of it, to defend themselves from the mire.

In classic authors, we frequently find the buskin used to signify tragedy itself, in regard it was a mark of tragedy upon the stage.

It is also to be understood for a lofty strain, or high style.

**BUSS**, in maritime affairs, a small sea-veffel, used by us and the Dutch in the herring-fishery, commonly from forty-eight to sixty tons burden, and sometimes more: A buss has two small sheds or cabins, one at the prow, and the other at the stern; that at the prow serves for a kitchen.

Every buss has a master, an assistant, a mate, and seamen in proportion to the vessel's bigness: the master commands in chief, and without his express order the nets cannot be cast, nor taken up; the assistant has the command after him; and the mate next, whose business is to see the seamen manage their rigging in a proper manner, to mind those who draw in their nets, and those who kill, gut, and cure the herrings, as they are taken out of the sea: The seamen do generally engage for a whole voyage in the lump. The provision which they take on board the busses, consist commonly in bisket, oat-meal, and dried or salt fish; the crew being content for the rest with what fresh fish they catch. See **FISHERIES**.

**BUST**, or **BUSTO**, in sculpture, &c. a term used for the figure or portrait of a person in relieve, shewing only the head, shoulders, and stomach, the arms being lopped off: it is usually placed on a pedestal or console.

M. Felibien observes, that though, in painting, one may say a figure appears in busto, yet it is not properly called a bust; that word being confined to things in relieve. The bust is the same with what the Latins called *herma*, from the Greek *hermes*, Mercury, the image of that god being frequently represented in that manner by the Athenians.

**BUSTARD**, in ornithology. See **OTIS**.

**BUSTUARI**, in Roman antiquity, gladiators who fought about the bustum, or funeral pile of a deceased person of distinction, in the ceremony of his obsequies.

This custom was found to be less barbarous than the first practice was of sacrificing captives at the bustum, or on the tomb of warriors; instances whereof we meet with both in Roman and Greek antiquities: the blood spilt on this occasion, was supposed to appease, by way of sacrifice, the infernal gods, that they might be more propitious to the manes of the deceased.

**BUSTUARIÆ МОЕЧНÆ**, according to some, women that were hired to accompany the funeral, and lament the loss of the deceased: but others are of opinion, that they were rather the more common prostitutes, that stood among the tombs, graves, and other such lonely places.

**BUSTUM**, in antiquity, a pyramid or pile of wood upon which were anciently placed the bodies of the deceased, in order to be burnt. Some authors say, that it was properly called bustum after the burning,

*quasi beneustum*; that before the burning it was called *pyra*, and during the burning, *rogus*.

The bustum in the Campus Martius was encompassed round with white stone, and an iron rail.

**BUTCHER**, a person who slaughters cattle for the use of the table, or who cuts up and retails the same.

Among the ancient Romans, there were three kinds of established butchers, whose office was to furnish the city with the necessary cattle, and to take care of preparing and vending their flesh. The *suarii* provided hogs; the *pecuarii* or *boarii*, other cattle, especially oxen; and under these was a subordinate class, whose office was to kill, called *lanii*, and *carnifices*. To exercise the office of butcher among the Jews with dexterity, was of more reputation than to understand the liberal arts and sciences. They have a book concerning shamble-constitution; and in case of any difficulty, they apply to some learned rabbi for advice: nor was any allowed to practise this art, without a licence in form; which gave the man, upon evidence of his abilities, a power to kill meat, and others to eat what he killed; provided he carefully read every week for one year, and every month the next year, and once a quarter during his life, the constitution above mentioned. We have some very good laws for the better regulation and preventing the abuses committed by butchers. A butcher that sells swine's flesh meazled, or dead of the murrain, for the first offence shall be amerced; for the second, have the pillory; for the third, be imprisoned and make fine; and for the fourth, abjure the town. Butchers not selling meat at reasonable prices, shall forfeit double the value, leviable by warrant of two justices of the peace. No butcher shall kill any flesh in his scalding-house, or within the walls of London, on pain to forfeit for every ox so killed, 12d. and for every other beast, 8d. to be divided betwixt the king and the procurator.

**BUTCHER-BIRD**, in ornithology. See **LANIUS**.

**BUTCHER'S-BROOM**, in botany. See **RUSOUS**.

**BUTE**, an island of Scotland, lying in the mouth of the frith of Clyde, south of Cowal in Argyleshire. It gives the title of earl to a branch of the Stuart family. Bute and Cathness send only one member to parliament between them, each choosing in its turn, whereof Bute has the first.

**BUTEO**, in ornithology, the trivial name of a species of falco. See **FALCO**.

**BUTLER**, the name anciently given to an officer in the court of France, being the same as the grand echançon, or great cup-bearer of the present times.

**BUTLER**, in the common acceptation of the word, is an officer in the houses of princes and great men, whose principal business is to look after the wine, plate, &c.

**BUTLERAGE** of wine, is a duty of two shillings for every ton of wine imported by merchants strangers; being a composition in lieu of the liberties and freedoms granted to them by king John and Edward I. by a charter called *charta mercatoria*.

Butlerage was originally the only custom that was payable upon the importation of wines, and was taken and received by virtue of the regal prerogative, for the

the proper use of the crown. But for many years past, there having been granted by parliament subsidies to the kings of England, and the duty of butlerage not repealed, but confirmed, they have been pleased to grant the same away to some nobleman, who, by virtue of such grant, is to enjoy the full benefit and advantage thereof, and may cause the same to be collected in the same manner that the kings themselves were formerly wont to do.

**RUTMENTS**, in architecture, those supporters or props on or against which the feet of arches rest.

**BUTMENT** is also the term given to little places taken out of the yard or ground-plot of a house, for a buttery, scullery, &c.

**BUTOMUS**, in botany, a genus of the enneandria hexagynia class. It has no calix; the corolla consists of six petals; and the capsules are six, containing many seeds. There is but one species, *viz.* the *umbellatus*, flowering-rush, or water-gladiole, a native of Britain.

**BUTRINTO**, a port-town of Epirus, or Canina, in Turkey in Europe, situated opposite to the island of Corfu, at the entrance of the gulph of Venice: E. long. 20° 40', N. lat. 39° 45'.

**BUTT**, in commerce, a vessel or measure of wine, containing two hogheads, or 126 gallons. See **PIPE**.

**BUTT**, or **BUTT-ENDS**, in the sea-language, are the fore-ends of all planks under water, as they rise, and are joined one end to another.

Butt-ends in great ships are most carefully bolted; for if any one of them should spring or give way, the leak would be very dangerous and difficult to stop.

**BUTTER**, a fat unctuous substance, prepared from milk by heating or churning it.

It was late ere the Greeks appear to have had any notion of butter; their poets make no mention of it, and yet are frequently speaking of milk and cheese.

The Romans used butter no otherwise than as a medicine, never as a food.

The ancient Christians of Egypt burnt butter in their lamps instead of oil; and in the Roman churches, it was anciently allowed, during Christmas time, to burn butter instead of oil, on account of the great consumption of it otherways.

For the making of butter, when it has been churned, open the churn, and with both hands gather it well together, take it out of the butter-milk, and lay it into a very clean bowl, or earthen pan; and if the butter be designed to be used sweet, fill the pan with clear water, and work the butter in it to and fro, till it is brought to a firm consistence of itself, without any moisture. When this has been done, it must be scotched and sliced over with the point of a knife, every way as thick as possible, in order to fetch out the smallest hair, mote, bit of rag, strainer, or any thing that may have happened to fall into it. Then spread it thin in a bowl, and work it well together, with such quantity of salt as you think fit, and make it up into dishes, pounds, half pounds, &c. The newer the butter is, the more wholesome and pleasant it is; and that which is made in May, is esteemed the best.

There are as many sorts of butter, as there are different milks of animals whereof to make it: That of the cow is most in use. It is used every where, and there is hardly any sauce made without it. The northern people, however, make more use of it than others.

Every barrel of butter, imported from abroad, pays a duty of 3s. 10<sup>2</sup>/<sub>8</sub>d. whereof 3s. 4<sup>1</sup>/<sub>2</sub>d. is drawn back on exporting it. Irish butter pays only a duty of 1s. 11<sup>1</sup>/<sub>8</sub>d. the hundred weight; whereof 1s. 8<sup>1</sup>/<sub>8</sub>d. is drawn back on exporting it.

**BUTTER** among chemists, a name given to several preparations, on account of their consistence resembling that of butter; as butter of antimony, of arsenic, of wax, of lead, of tin. See **CHEMISTRY**.

**BUTTER-BUR**, in botany. See **PETASITES**.

**BUTTER-FISH**. See **BLENNIUS**.

**BUTTERFLY**, the English name of a numerous genus of insects. See **PAPILIO**.

**BUTTERFLY-FISH**, a species of the blennius. See **BLENNIUS**.

**BUTTERFLY-SHELL**, in natural history. See **VOLUTA**.

**BUTTERIS**, in the menage, an instrument of steel, fitted to a wooden handle, wherewith they pare the foot, or cut the hoof of a horse.

**BUTTER-MILK**, a kind of serum that remains behind, after the butter is made.

**BUTTER-WORT**, in botany. See **PIRGUICULA**.

**BUTTERY**, a room in the houses of noblemen and gentlemen, belonging to the butler, where he deposits the utensils belonging to his office, as table-linen, napkins, pots, tankards, glasses, cruetts, salvers, spoons, knives, forks, pepper, mustard, &c.

**BUTTOCK** of a ship, is that part of her which is her breadth right astern, from the tack upwards; and a ship is said to have a broad or a narrow buttock, according as she is built broad or narrow at the transum.

**BUTTON**, an article of dress, serving to fasten cloaths tight about the body, made of metal, silk, mohair, &c. in various forms. Metal-buttons are either cast in moulds, in the manner of other small works, (see **FOUNDRY**), or made of thin plates of gold, silver, or brass, whose structure is very ingenious, though but of little use.

Buttons of all sorts are prohibited to be imported.

**BUTTON**, among gardeners, denotes much the same with bud. See **BUD**.

**BUTTON**, in the menage. Button of the reins of a bridle, is a ring of leather, with the reins passed thro' it, which runs all along the length of the reins. To put a horse under the button, is when a horse is stopped without a rider upon his back, the reins being laid on his neck, and the button lowered so far down that the reins bring in the horse's head, and fix it to the true posture or carriage. It is not only the horses which are managed in the hand that must be put under the button; for the same method must be taken with such horses as are bred between two pillars, before they are backed.

**BUTTON'S bay**, the name of the north part of Hudson's bay, in North America, whereby Sir Thomas Button

Button

Button attempted to find out a north-west passage to the East Indies. It lies between 80° and 100° W. long. and between 60° and 66° N. lat.

**BUTTRESS**, a kind of butment built archwise, or a mass of stone or brick, serving to prop or support the sides of a building, wall, &c. on the outside, where it is either very high, or has any considerable load to sustain on the other side, as a bank of earth, &c.

Buttresses are used against the angles of steeples and other buildings of stone, &c. on the outside, and along the walls of such buildings as have great and heavy roofs, which would be subject to thrust the walls out, unless very thick, if no buttresses were placed against them. They are also placed for a support and butment against the feet of some arches, that are turned across great halls in old palaces, abbeys, &c.

**BUTZAW**, a town of Lower Saxony, in Germany; it stands upon the river Varnow, on the road from Schwerin to Rostock.

**BUXTON**, a place in the peak of Derbyshire, celebrated for medicinal waters; the hottest in England, next to Bath.

**BUXTON-wells**. The strata of earth and minerals, in the parts adjacent to Buxton, are peat-moss, blue clay, iron, and coal, mixed with sulphur and brazil.

The warm waters there, at present, are the bath, which takes in several warm springs; St Ann's well, a hot and cold spring rising up into the same receptacle; and Bingham-well.

These waters greatly promote digestion, unless they are drunk too long, in which case they relax the stomach, and retard digestion; they are well adapted to obstructions of every kind, whence they produce surprising effects in gouty, rheumatic, athritic, and scorbutic pains. As this water is warm, highly impregnated with a mineral steam, vapour, or spirit, it is signally beneficial to cramps, convulsions, dry asthma, the bilious colic, stiffness, &c.

They advise both drinking and bathing in the use of these waters; only the last is of bad consequence in the gout, inward inflammations, fevers, dysentery, large inward tumours, or in an outward pressure of the body.

**BUXUS**, in botany, a genus of the monœcia tetrandria class. The calix of the male consists of three leaves; and the corolla has two petals: The calix of the female has four leaves; the petals are three; it has three styli; and the capsule has three cells containing two seeds. There is but one species, viz. the sempervirens, or box-tree, a native of Britain. A decoction

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of the leaves and wood has been recommended as a powerful sudorific; but is not now used by practitioners. The wood is of a hard close texture, and is greatly used by mechanics for tools of various kinds.

**BUYS**, a town of Dauphine, in France, situated on the confines of Provence; E. long. 5° 20', and N. lat. 44° 25'.

**BUZZARD**, in ornithology, the English name of several species of the hawk kind. See FALCO.

**BYGHOF**, or **BYGOW**, a city of Lithuania in Poland, situated on the river Nieper; E. long. 30°, and N. lat. 53°.

**BY-LAWS**, or **BYE-LAWS**, private and peculiar laws for the good government of a city, court, or other community, made by the general consent of the members.

All by-laws are to be reasonable, and for the common benefit, not private advantage of any particular persons, and must be agreeable to the public laws in being.

**BYRLAW**, or **BURLAW laws**, in Scotland, are made and determined by neighbours, elected by common consent in byrlaw courts. The men chosen as judges, are called byrlaw or burlaw men, and take cognizance of complaints between neighbour and neighbour.

**BYRRHUS**, in zoology, an order of insects belonging to the order of coleoptera. The feelers are clavated, pretty solid, and a little compressed. There are five species, all of which are to be found on particular plants, and principally distinguished from each other by the colour and figure of the elytra or crustaceous wing-cases.

**BYSSUS**, in botany, a genus of mosses belonging to the cryptogamia algæ. The character is taken from this circumstance, that they are covered with a simple capillary filament or down, resembling soft dust. The species are 15, all natives of Britain.

**BYSSUS**, in antiquity, that fine Egyptian linen whereof the tunics of the Jewish priests were made.

Philo says, that the byssus is the clearest and most beautiful, the whitest, strongest, and most glossy sort of linen; that it is not made of any thing mortal, that is to say, of wool, or the skin of any animal, but that it comes out of the earth, and becomes always whiter, and more shining, when it is washed as it should be.

**BYZANT**. See **BEZANT**.

**BYZANTIUM**, the ancient name of Constantinople. See **CONSTANTINOPLE**.

**BZO**, a town of Africa, in the kingdom of Morocco.

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## E R R A T A

Page 127. column 2. end of the first paragraph, read *Plate XI. fig. 3.*; and at the end of the next paragraph, *Plate XI. fig. 2.*


End of the article AMPHISBOENA, read *Plate XII. fig. 2.*

*St Andrew's day.* For the *thirteenth*, read the *thirtieth* of November.

Page 466. col. 1. l. 52. for *vkA*, read *ikA*.

Page 467. col. 1. l. 12. supply *Plate XLIII. fig. 4.* to which the reference-letters and figures in the paragraph belong.

Page 468. col. 1. l. 26. for *fig. 3.* read *fig. 5.*

In fig. 9. of Plate LI. the *Baston*, or *Bastard-bar*, is represented in a wrong direction. It should run thus, .

Bos. End of par. 2. *del.* Plate LII. fig. 2. which is

not a figure of the common bull, but of the *Rifon*, described p. 625. col. 2.

In the article BRETON, for *subject to the English*, read *subject to the British*.

Plate 47. represents a different *Orrery* from the one described. The right one will be engraven, and delivered in due time.

BOOK-KEEPING. A variety of preliminary Problems, Cafes, &c. referred to by the letters and numbers which the reader will observe subjoined to the examples in the *Waste-book*, were by accident omitted in the printing; but will be printed and given in proper time, with directions for inserting them.—*So that this and the preceding article may be expunged from this list when the book is bound.*

\* \* \* It is humbly hoped, that the above faults, with others which may have escaped notice, or are here omitted as trivial, will be candidly deemed venial in a work so complex, so various, and so extensive as the present.